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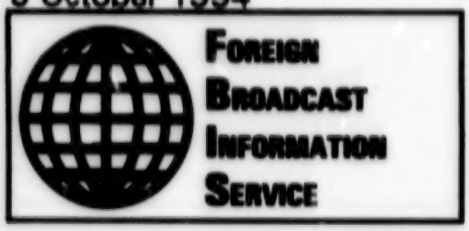

JPRS Report

Science & Technology

Central Eurasia: Space

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JPRS-USP-94-007 CONTENTS *5 October 1994*

[NOTICE TO SUBSCRIBERS: Publication of the CENTRAL EURASIA: SPACE Report will cease as of January 1995. Coverage of CIS space activities will continue as a subsection of the report series CENTRAL EURASIA: SCIENCE AND TECHNOLOGY.]

[NOTE TO READERS: Effective 1 October, the processing indicators appearing in brackets at the start of each item will be changed. All new indicators will begin with "FBIS" to make the material more easily identifiable. Some will also indicate whether the item has been translated from the vernacular or transcribed from English.]

MANNED MISSION HIGHLIGHTS

SPACE SCIENCES

SPACE ENGINEERING

SPACE APPLICATIONS

SPACE POLICY, ADMINISTRATION

Psychological Aspects of Theory and Practice of Manned Cosmonautics

947Q0164A Moscow PSIKHOLOGICHESKIY ZHURNAL in Russian Vol 15 No 3, May-Jun 94 pp 176-178

[Article by Yu. N. Glazkov, doctor of technical sciences, V. I. Kryuchkov, candidate of technical sciences, N. V. Krylova, candidate of biological sciences, and I. S. Zamaletdinov, professor, doctor of psychological sciences, candidate of medical sciences]

[FBIS Translated Text] During October of last year the Gagarin Cosmonaut Training Center held an international scientific-practical conference on the theme "Professional Activity of Cosmonauts and Ways To Increase Its Efficiency." Its principal objective was to evaluate the present-day level of research and practical results in the field of training and professional activity of cosmonauts, determination of directions for their further improvement, and also ways to facilitate the development of international cooperation.

Representatives of the leading organizations and institutes of Russia and other countries carrying out work in the field of manned cosmonautics were invited to the conference. In particular, specialists of our Cosmonaut Training Center, European Astronauts Center, French National Space Research Center, German Aviation and Cosmonautics Research Center and Chinese Space Medicine Institute. The arrival of foreign representatives at the conference, despite the unfavorable political situation in Russia in early October, gave evidence of the great international reputation of the Gagarin Cosmonaut Training Center and the active striving of foreign centers for the exchange of information on space problems, examination of promising directions in join work, establishment of direct contacts, and also the desire to become acquainted with the experimental base of the Gagarin Cosmonaut Training Center.

During the 33 years of operation of the Cosmonaut Training Center (jointly with other institutes and organizations of Russia and foreign countries) much research has been carried out and extensive data have been accumulated on the professional activity of cosmonauts and the system for special training of man for life and work in space, without which he cannot be successfully adapted to unusual weightlessness conditions. Since 1960 in Russia and the United States there have been centers for the recruitment and training of cosmonauts (astronauts) which are constantly continuing to develop. Today citizens of 25 countries have made flights in Russian and American manned ships and orbital stations. In addition, the high cost of space flights, the complexity of their organization and implementation, rigorous requirements on ensuring man's safety during space flights and the inadmissibility of irreversible changes in the human body after presence in orbit are the principal circumstances restraining the broadening of manned flights. A problem of decisive importance is that of increasing the efficiency of the work of cosmonauts aboard manned spacecraft, also including a search for ways to increase the efficiency of the work of cosmonauts by improving their professional and psychomedical training.

These matters became the principal subject of discussion and exchange of information among the leading specialists of the different countries. The work of the conference transpired simultaneously in three sections: problems in the professional activity of cosmonauts, study of the professional activity of cosmonauts and ways to increase its efficiency and psychomedical problems in increasing the efficiency of cosmonaut activity. It was quite difficult to achieve a clear separation of the discussed subjects; psychological aspects are present everywhere. For example, in the first section, in addition to discussion of matters of a strictly professional character with respect to organization, methodology, trainer-simulation and informational-technical support of the space training process, a study also was made of psychological engineering problems. And this is not by chance because the increasing complication of space orbital complexes and flight activity programs for cosmonauts impose on them enormous intellectual and physical loads even during the preflight period of their professional training. Under these conditions it is difficult to count on an increase in the efficiency of training measures without applying the advances in psychology and pedagogy. That is why at the Gagarin Cosmonaut Training Center an evening special faculty for increasing the psychological- pedagogic skills of specialists in the training of cosmonauts, in the initiation and support of which the Moscow Pedagogic State University imeni V. I. Lenin exerted and continues to exert great assistance, has already been in operation for the fifth year.

The psychological aspects of the work of cosmonauts also was reflected in the work of the second section. This touched on the ergonomic optimization of the conditions for the life and work activity of cosmonauts aboard orbital complexes; rational algorithmization of the actions of a cosmonaut when using the technical systems of manned space vehicles, engineering structures, shipboard manipulators and instruments; modern and reliable notification of cosmonauts about nonstandard and emergency situations and the reasons for their appearance using automatic monitoring systems; increase in the on-line character of informational interaction between cosmonauts and surface control services; timely development and introduction into practical space work of new image-recognition and nontrivial mnemolanguage information systems for the coding, transmission and reception of different communications.

Communications on the characteristics of activity of cosmonauts outside ships, as well as work on ecological monitoring, received special attention at the section sessions. Activity carried on outside a ship by cosmonauts during their walks in open space has become a quite typical phenomenon in the practice of manned cosmonautics, but its theoretical study for the time being still lags substantially behind the practical level of development. The rich phenomenological content and exceptional importance of activity outside a ship advances it into the ranks of one of the most timely problems in different scientific disciplines,

including psychology. The principal stress factors associated with work outside a ship were defined against this background. The following were noted among them: the risk of the appearance of emergency situations, a deficit of allocated work time, a change in the sensory field of afferentiation, emotional and physical loads, need for constant adherence to safety measures and interaction with a crew partner and surface services for the support of activity outside a ship and also rigorous regulation of the activity cyclogram.

The successful experience of more than 50 walks of Russian cosmonauts in open space, the total duration of whose work is about 200 hours, is a reflection of the thoroughly worked out system for professional training at the Cosmonaut Training Center with respect to activity outside a ship. Its principal highlights are: attainment of a high professional level of instruction; instilling of confidence in the reliability of technical equipment, space suit and control instruments; formulation of an adequate conceptual model of impending activity; working out of crew interaction for control and assistance; teaching of optimum informational interaction. The very fact of reality of active functioning of cosmonauts in open space (when they frequently exhibit inventiveness, a heuristic, creative approach to the handling of unforeseen transpiring situations) gives evidence of the enormous capabilities of the human psyche to adapt effectively to conditions only very recently regarded as extremal for man. This fact, in correspondence with the convictions of K. E. Tsiolkovskiy and S. P. Korolev on the immediate prospects for man's large-scale mastery of the expanses of the universe, is opening up new horizons for the reflections of psychologists and the further development of the science of psychology.

A lively response among conference participants was evoked by communications of cosmonauts and representatives of a number of regions of Russia on the results from and prospects for space ecological monitoring of the Earth's surface. These studies, in addition to the on-line character of the collection of new information, its high reliability and systemic-meaningful representation level, as well as economic profitability, also have an inestimably great importance in the scientific formulation of measures for the monitoring and preservation of ecological conditions on the Earth. They served as a basis for developing the concept of a predominant influence of the totality of terrestrial and circumterrestrial physical fields on natural features and processes on the Earth, jointly and simultaneously experiencing the influence of cosmic cycles of different duration which are regular in time and space.

And on the basis of this concept specialists of the Cosmonaut Training Center, International Center for Teaching Systems and other institutes have already developed procedures and a technology for constructing physical geology models of fields, a methodological approach for carrying out combined implementation of systematic aerospace, surface, underground and oceanological studies in real time, as well as a curriculum for the training of corresponding specialists at the Cosmonaut Training Center base. A project for future work in this field was presented to the UNESCO secretariat for the program for 1994-1995. The French State Institute for Applied Sciences expressed a desire to be included in this project.

The curriculum for the training of specialists in the field of combined ecological monitoring already has been checked out on a group of specialists and cosmonauts with different backgrounds. The results of the purposeful activity of this group indicate a highly promising future for the balanced use of the environment, conservation of resources and environmental protection. All this is affording new possibilities for psychological support in the application of space research in solving of terrestrial problems.

Great attention to the psychological theme was given in sessions of the third section, where there was discussion of the biomedical aspects of recruitment and training of cosmonauts, the state of their health during flights and during the postflight period. The importance of launch factors in the pathogenesis of psychosomatic illnesses was linked to psychological phenomena and clinical symptoms in the state of health were interpreted from the point of view of the level of their psychosomatic involvement. Several problem areas were clearly defined:

1. Psychophysiological. This includes problems relating to the evaluation and prediction of man's functional state under spaceflight conditions, evaluation and prevention of fatigue, simulation of physiological effects of the adaptation syndrome and organization of daily activity during prolonged flights.

2. Psychological. This includes the methodological aspects of the psychological training of cosmonauts, evaluation of the characteristics of psychological compatibility of a crew and psychological preparation using training equipment, as well as evaluation of the psychological characteristics of cosmonauts from the standpoint of an original model of the "periodic system of the human psyche."

3. Psychodiagnosis and psychoprophylaxis. Problems related to professional recruitment, instilling of professionally significant qualities and their automated evaluation, psychological training for activity under extremal conditions and in-flight psychological support of cosmonauts were concentrated in this field.

A communication on a new interpretation of the mechanism of development of asthenic and neurotic states in cosmonauts during prolonged flights, including the physiogenic basis of their formation due to the regular influence of the weightlessness effect on the organic substrate of the psyche—the brain (it is constantly in a state of increased blood filling and because of this there is a more or less expressed tissue edema with corresponding hypoxic and metabolic deviations) was of special interest. The presented objective data on the increasing burdening of the psychoneurological states of cosmonauts after flights due to the increasing durations of spaceflights were responsible for the lengthier discussions devoted to the interpretation of these and other

materials of a biological, physiological and medical content as clinical manifestations of a new nosological unit in medicine—weightlessness disease.

The continuing silence on the unfavorable influence of man's prolonged exposure to space conditions on his health only restrains the timely development of more modern and new prophylactic measures, including the development of artificial gravity systems on space complexes, and also does not make it possible for the public to evaluate adequately the professional work of cosmonauts. Proposals on the need for carrying out systematic research on the basis of the prolonged study of the state of health of cosmonauts after flights, including the state of the neurohormonal, immune, endocrinal, genetic and other body systems, were deemed timely.

In evaluating the results of this conference it must be noted that it completely satisfied the formulated objectives, and this constituted a great service of the Cosmonaut Training Center and the initiatives of the directors of a number of military, academic and government departments in Russia supporting it. It is to be hoped that such conferences will be held regularly and that in addition to the publication of summaries of the reports there will be publication of a collection of expanded scientific communications, which undoubtedly will be extremely useful for specialists working for the good of manned cosmonautics.

ESA Financing 135-Day Spaceflight Simulation

947Q0168A Moscow SEGODNYA in Russian 1 Sep 94 p 9

[Article by Veronika Romanenkova: "Three in Ground Flight. Russia Cosmonauts Rest in Bed for Europe"]

[FBIS Translated Text] Three Russian specialists—Vasiliy Lukyanyuk, Igor Nichiporuk and Vladimir Karashtin—are beginning a more than four- month "space flight" today at the Institute for Biomedical Problems (IMBP). For 135 days they will be in total isolation from the outside world in a mock-up of the Mir orbital complex. Their conditions of habitation and professional activity will correspond to the greatest degree possible to real conditions: gas composition of atmosphere, work and rest schedule, operator activity, water consumption, prophylactic training sessions and hygienic procedures. Even contacts between the crew and service personnel will be conducted as communication sessions. An exception has been made only for the duty doctor, who will make contact at least three times a day in order to conduct routine medical monitoring.

Such a condition was set by the client ordering the experiment—the European Space Agency (ESA). One of its ten astronauts should make the longest space flight for the ESA aboard the Mir together with two Russians in 1995 (Euromir-95 program). But appropriate preparation is needed for this—a model experiment similar to the flight in duration, conditions of habitation and crew activity.

The experiment, called HUBES (Human Behaviour in Extended Spaceflight), was completely paid for by the European Space Agency. The IMBP declined to mention the amount of the contract. Nevertheless, it can be assumed that the implementation of such an order is extremely advantageous for the institute because only such "commercial activity" will save the day considering the economically critical conditions in the branch.

The volunteer cosmonauts, having undergone rigorous selection, also stand to gain. Not only professional interest, but also a respectable monetary compensation, are inducing them to "detach themselves" from terrestrial problems for several months. In addition, the experiment will be a consolation for two of them (Lukyanyuk and Karashtin), who underwent the general space training program, who were granted the status of cosmonaut-researchers, but who have not been in space.

ESA specialists will be able to compare and check the adequacy of the psychological measures and techniques employed in the stages of selection, training and monitoring the health and activity of a crew during flight. They will select the most effective measures and techniques for evaluating and supporting the vital functions of a crew under real spaceflight conditions. In addition, they will obtain additional information on the requirements imposed on man under prolonged spaceflight conditions.

The fulfillment of a program of tests in the Mir mock-up also is assigned considerable importance. Thirty-one methods proposed by scientific groups from Great Britain, Germany, Netherlands, Italy, Norway, Russia, United States, France, Czech Republic and Switzerland were selected on the basis of an international competition. The research will be conducted in several directions: individual and group psychology in a closed space, chronobiology, physiology, neuroimmunology, nutrition and professional activity.

When carrying out medical-physiological research use will be made of both shipboard scientific research instrumentation and medical apparatus employed in pre- and postflight clinical-physiological examinations of cosmonauts.

Cosmonauts Unfairly Blamed for Failure of Soyuz-15 Flight

947Q0169A Moscow KRASNAYA ZVEZDA in Russian 9 Sep 94 p 2

[Article by Mikhail Rebrov, KRASNAYA ZVEZDA correspondent: "Bitter Aftertaste of Glory"; the first two paragraphs are an introduction]

[FBIS Translated Text] In Russia there are 78 who have the professional right to be called flier-cosmonauts, those who have been beyond the limits of the Earth and have worked in orbit. It would seem that only quite recently each launch was an outstanding event which excited our imagination, impacted our feelings, arousing both pride and curiosity and delight. But time has passed and we have forgotten them. Both about the launches themselves and the people who went into the unknown. Both have become another line in space activity annals. And in a way this is natural. After all, we earthlings are already storming space for a fourth decade. But simplifications have not set in and today on every flight not

only equipment, but man himself, are put to the test. Man's character, his will and his fate. And there is more than a small risk in each flight. Alas, that is the case.

I want to tell of an "unknown" flight which is already covered by the dust of history. And not at all because one of its participants was my old-time comrade from the days of studies at the Zhukovskiy Academy. I want to glance back and from today's point of view take a look at the evaluations of the past. For the sake of correctness.

It happens that he suddenly awakens in the middle of the night from some unknown impulse and clear but broken pictures of events long past thunder before him until morning, once again forcing him to experience the first and last appointment in space. Twenty years have passed and everything seems like it was yesterday.

...That August the brilliant sun burned down mercilessly on the Baykonur steppe, which sloped up and down and was sunk in silence. The lazy hot wind dried the sweaty faces, raised the dust and drove it into the distant nowhere. In the intense heat, dry due to evaporation, the days of prelaunch preparation dragged out into long hours of waiting for the evening coolness...

He heard the voice of Gennadiy Sarafanov, the Soyuz-15 commander: "Lev, it's time for the trainer." He forced himself awake, almost crying out: "I'm coming!," but immediately getting a grip on reality, calmed himself: "Well, enough of that, I'll see what I can do..." He rose quietly in order not to awaken the domestic help, took a cigarette and went into the kitchen. After a first drag his thoughts again carried him into the past.

The TASS communication breathed optimism. It announced that the Soyuz-15 spaceship had been launched from the Baykonur cosmodrome on 26 August 1974. There was a two-man crew: ship commander Gennadiy Sarafanov and ship's engineer Lev Demin. The cosmonauts carried out experiments for perfecting pilotage techniques in different flight modes. In the course of maneuvering the ship repeatedly made approaches to the Salyut-3 station and the cosmonauts carried out its external inspection. The Soyuz-15 landed on the Earth in total darkness. The possibility of returning to a stipulated region of the Earth at any time of day was demonstrated.

That was really all that we learned about this flight at that time. Later there were decrees, Gold Stars, etc., intended to impress the unsophisticated. The more inquisitive asked the question: is it possible that they flew for the sake of maneuvers and an inspection? It turned out that they left the Earth for two days and they were given the title Hero. And glory for all the rest of their life. Isn't that so? All this was a lie. The flight program had provided for docking with the station and working in orbit for 25 days. And they did not go in the Salyut. In all the technical documentation the station was called Almaz or DOS (long-term orbital station). Both these names bore the stamp "Secret." The Almaz differed in its purpose from the Salyuts, which were developed at the OKB-1 (the S. P. Korolev enterprise, now the NPO Energiya). This was a military object developed by specialists at the OKB-52, headed by V. N. Chelomey. With respect to "the only two days," behind them stretched the entire life which both of the crew members had lived. Well, glory, even merited, at times has a bitter aftertaste.

Thus, it was the August of 1974. They were launched at nighttime.

The objective of the flight was initially simple: after entry into orbit, check whether everything was deployed, functioning in accordance with the program, was ready for what was to come... Corrections were made without anything going amiss. The ground confirmed: "Everything is OK. Rest, take care of the rest later." ("Later" meant in the morning.)

The new workday began earlier than planned. The "Dunays" (the call letters of the crew) had not slept and the operators at the flight control center also did not delay in entering into communication because it was planned that the docking be executed outside the zone of radiovisibility.

The distant approach stage began. Each minute the Soyuz-15 shortened the distance to the station. Soon they saw its lights, and then its structural outlines. The elongated "barrel" majestically floated forward with the "wings" of its solar cells spread out. Several more propulsion- braking maneuvers and a docking mode would begin. And right then the two in the ship more likely sensed than noted that the engine was firing contrary to the approach logic: instead of braking there was propulsion, and vice versa. That had to be thought out. But in space there are only seconds available for finding solutions concerning suddenly arising problems. There is no time at all for the correction of errors.

The situation in orbit turned out to be serious. Was it necessary to explain how fraught with danger was the collision of two multiton vehicles? This had to be recognized and then a split-lightning and correct decision had to be made. Demin's brain operated far more reliably than the ill-starred engine. "The ship jumped seven meters past the station," he estimated with a skilled eye.

Still another attempt. Still another tortured effort to "outwit" the engine and again something did not function properly in the highly complex control system...

Excited conversations took place with the flight control center. The crew had to report about everything, to transmit instrument data and to report on the reaction of "objects" to the transmission of various commands. And that is what they did. They evaluated the situation far more accurately than those who were on the ground, but permission to act in accordance with the conditions was not received.

The ship disappeared from the zone of radiovisibility and there was a break in radio communications. Demin and Sarafanov strove to conceal their irritation. In the last analysis it was necessary to trust the automatic pilot, to respect it if it laid a path in the direction of the same star. The flight was not the objective, but a means, and the ship was a tool. Even during training sessions they

had understood that action elevates man, whereas inertia is a form of hopelessness.
Overcoming short hesitations, the ground issued the order: "Cease further attempts. Prepare for a landing. Do not suspend activity—return at night." The response from orbit was: "Message received and understood."

That was it! They would not reach the station. This fact did not sink in as fully as might be expected. However, they could be understood: after all, they went there and felt that each revolution, each minute the target was coming closer...

Demin does not remember when it sank in. Possibly at the moment when he realized that the flight had been called off. Not the flight itself—its assigned mission: reach the station and perform the assigned tasks. They had prepared themselves for that. And here was the response from the flight control center—whether serious or in jest: "Lads, you will tame the night." And what, really, was the difference: a landing during the daytime or at night? They had prepared for any variant.

The crew had nothing to reproach itself for. Indeed, there was nothing for which others could reproach them: they had done everything, conforming to the situation and adhering to the restrictions which the flight control center did not which to remove. What more could be done? A risk could be taken and they were ready to take this risk, to demonstrate that they could handle anything. Not intuitively. but by sober calculation. Especially since it was all worthwhile. But the ground decided otherwise.

They had no regrets. They had played and lost. It was like a crash on takeoff, when the engine fails. So it had happened with others. It was kept under wraps, but it had indeed happened.

How many times in a trainer had they docked with a station under the most different conditions? These conditions were made increasingly more complex. There were glitches, but they stubbornly repeated approaches again and again in order to achieve contact. It seemed that everything had been worked out, everything had been taken into account. Now in real flight there would be no errors, no blunders. So it would seem... But it is insufficient to prune a tree in order for it to flower; it also is necessary that spring intervene. The equipment must perform as reliably as man has learned to act.

They say that one unpleasantness is unlike another. That's true. So it happened: it never rains but it pours. The last revolution, that for the landing. The GBA and GBB tumblers were thrown at the calculated time for spinning of the gyroscopes stabilizing the ship prior to firing of the braking engine. Control was by instrument and by shipboard timer. And then it had to happen: the ammeter went off scale. A short circuit?! "All we need is a fire," stormed Demin. "They might as well bring an ambulance to the landing region!" retorted Sarafanov.

They joked, but each was aware that there might be no landing. To cut off the tumblers and try again would entail a loss of time. In orbit every second counts. Take a risk? Possibly the gyroscope had already been somehow properly activated. And if not? Well, that way one might remain in space forever and die a slow tortured death. What to do if they chanced to be captives of space?

"Don't sulk and let it get to you, old chap," said Demin in calming himself. In training sessions he had been able to keep his nerves in check and surprised the overparticular physicians with his "objective indices."

"I am keeping track with my wristwatch," he reported to the commander.

Did it seem terrible to them at that time? Indeed it did. After all, they were ordinary people, like all of us. The only difference was that with professional speed they evaluate all the nuances of the situation and do not leave things to chance.

Fate saved them. The braking engine thrust the ship from orbit. But still another trial awaited them on the way to the Earth. A thunderstorm raged in the landing region. Intense lightning strokes rent the sky and it seemed that right there the sky would be transformed into an enormous parachute...

When they returned a flight analysis was made. They were forewarned: the state commission and the chief designers do not like it when a crew comments unfavorably on the equipment. "And what do they like?" asked Demin with a grin. In the analysis he did not put blame on the equipment, was restrained in his judgments, but did not shade the truth nor lie. The finale was stunningly unexpected: the blame for cutting off the flight program was put on the crew.

Something else is surprising: the secret report on this flight even today is stored securely in the safes at the NPO Energiya. The cosmonaut-researcher and engineer with a diploma from the famed Zhukovskiy Institute, candidate of technical sciences Colonel Lev Stepanovich Demin and the crew commander, first-class military flier and also a colonel, still have not received the right to familiarize himself with this document, written, in essence, with their life.

Unfortunately, KRASNAYA ZVEZDA was not given access to these documents and the Soyuz-15 mystery remains.

So it was that those who had taken upon themselves the direction of space programs for many years inspired us: "Soviet technology is the most reliable" and made up their own "glasnost" rules. And those who made ready for the launches were forced to live under these rules, holding their breath. And now, in the minutes of return to the past, cosmonaut 32 understands how naive he was when he assumed: "That's what's necessary to do the job." A feeling of bitter resentment for himself and the commander torments him from time to time, a response to the pain in his heart: "They disavowed us." And then he calms himself: "There is no need to be sad."

And all that is now history.

Evaluation of Characteristics of Waves and Tsunamis Generated by Falling of Asteroids and Comets in Oceans and Seas

947Q0156A Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 28 No 3, May-Jun 94 (manuscript received 8 Feb 9_) pp 81-89

[Article by I. V. Nemchinov, S. P. Popov and A. V. Teterev, Dynamics of Geospheres Institute, Russian Academy of Sciences; UDC 622.011.4:622.023]

[FBIS Translated Abstract] Numerical simulation was used in studying the impact of asteroids and comets with a diameter 6-10 km in an ocean with a depth 4-5 km. In such cases a water wall is generated with a height about equal to ocean depth at a distance about 25 km from the impact if impact velocity is about 20-30 km/s. With a decrease in body diameter to 2 km the height of the wall at these distances decreases to about 1 km. With a change in body diameter the nature of the water wall formation process changes. For bodies with a diameter 6-10 km it is generated by a bottom wall higher than the initial water level, but for a body with a diameter 2 km or less the bottom wall height is already less than the water level wall. During wave propagation from the impact point its amplitude attenuates approximately inversely proportionally to the radius, but remains quite high at great distances. For a body 2 km in diameter the wave height is about 10 m at a distance up to 2000 km. Tsunamis generated during the falling of quite small cosmic bodies may lead to catastrophic results at the regional and even global level. The interaction between the generated waves and underwater ridges and canyons may substantially change wave height and velocity in regions whose extent greatly exceeds the height of the ridges or the depth of the canyons and gives rise to an asymmetry in wave propagation from the impact site. The impact of the water wall against coastal ranges at distances of tens or hundreds of km may cause substantial relief changes. There is need for further study of the wave generation processes caused by the impact of bodies of different composition, configuration and size at different velocities in water bodies of different depth and also the processes involved in the propagation of such waves, their arrival in shallow waters and reflection from coastal mountains. Allowance must be made for real bottom and land relief in order to determine these processes more precisely and to make more reliable predictions of the destructive consequences of an impact. Figures 9; references 30: 16 Russian, 14 Western.

Prominent Role Seen for Small Satellites

947Q0173A Moscow SCIENCE IN RUSSIA in English No 4, Jul-Aug 94 pp 4-5

[Article by Yuri Kolesnikov: "Minor Satellites To Handle Major Tasks"; first paragraph SCIENCE IN RUSSIA comment]

[FBIS Transcribed Text] The staff of the Russian Electromechanics Research Institute (RERI) have drawn up blueprints for small-size general-purpose space vehicles carrying equipment to tackle various scientific and commercial tasks.

Years have slipped by when each space power was bending over backward to beat the other in the weight of objects it could launch into outer space. The might and prestige of states have now ceased to be reckoned in terms of carrier rocket power, while the political objectives sought in the now defunct arms race have given way to economic expediency. This explains why many countries have switched their attention to small-size satellites ranging in weight from 10 to 200 kg, 500 kg at the most. To give an example, more than 20 firms are engaged in developing such satellites in the United States. On its part, the National Aeronautics and Space Administration (NASA) launched an effort back in early 1990 to design a series of orbital vehicles appropriately called "minor explorers."

The "babies" really have many advantages, not least of which is their low price. Besides, they do not always need a carrier rocket of their own to be inserted into orbit, being content with hitching a free ride together with their bigger brothers, the standard multi-tonners. If, however, a carrier rocket is used to launch minor satellites, it could take up ten or more of them. Moreover, instead of building a special rocket, the prospective satellite operator can go to the market glutted with military rockets which have been deactivated as a result of conversion.

Minor satellites are capable of handling crucial and complex tasks, being equipped with state-of-art electronic gadgetry requiring minimum power and having diminutive dimensions.

Their numerous tasks include conducting wide-ranging meteorological observations, worldwide environmental monitoring, astronomical research, seismic activity tracking, measuring the ozone content in the atmosphere, and mapping the Earth's electromagnetic field. Mini- and micro-satellites will be appreciated by ham operators and crews and passengers of ships and airliners in distress.

Alternatively, these tasks can be dealt with by general-purpose small-size space platforms of models UMPK 1 and UMPK 2, which have been developed by RERI designers. Weighing 60 kg, a third of which is specialized equipment, UMPK 1 platforms will be launched into circular orbits at altitudes of 650 to 900 km, which they are to share with operating satellites of the *Resurs 0* or *Meteor 3* series. The heavier, 390 kg UMPK 2 platform carries 100 kg of scientific equipment. It will lift off on its own rocket, such as a modernized military *Start* rocket or another, more powerful reconverted rocket. In the latter case, two UMPK 2 satellites can be sent on a single rocket.

A comparison made between the RERI's small-size satellites and their foreign counterparts in terms of the design and parameters of their principal systems shows that they have approximately equal technological standards.

Conversion of SS-18's for Use as Space Launchers Proposed

947Q0171A Paris AIR & COSMOS/AVIATION INTERNATIONAL in French No 1483, 2 Sep 94

[Article by Christian Lardier: "The Formidable SS-18s Being Scrapped"]

[FBIS Translated Text] The START agreements call for Russia to liquidate all of its intercontinental ballistic missiles equipped with multiple independently targeted nuclear warhead reentry vehicles [MIRVed ICBMs] by the year 2003. The first phase concerns the very old (NATO-coded) SS-11 Sego, SS-13 Savage, and SS-17 Spanker missiles. A second phase will include the SS-18 Satan, SS-19 Stiletto, and SS-24 Scalpel. At the same time, the single-warhead SS-25 Sickle missile will become the Russian nuclear arsenal's principal vector.

The SS-18 Satan (NATO code) or R-36B/RS-20 (Russian designation) is the successor of the SS-9 Scarp. It is a 2-stage missile using dinitrogen tetroxide (N_2O_4) and heptyl (a UDMH [unsymmetrical dimethyl hydrazine] compound). The first stage is powered by a 460-ton-thrust motor with four combustion chambers, and the second by a single-chamber 77-ton-thrust motor. It was built by the M. K. Yangel OKB Yuzhnoye at Dnepropetrovsk (Ukraine). Designed during 1966-1972, this third-generation ICBM was tested beginning in November 1972, deployed in January 1975, then integrated with the weapons arsenal in December 1975. There are five variants: the single-warhead, 24Mt Mod-1; the 550Kt, 8-warhead MIRVed Mod-2; the single-warhead, 20Mt Mod-3; the 500Kt, 10-warhead MIRVed Mod-4; and the 500Kt or 750Kt, 10-warhead MIRVed Mod-5. Each of the 308 missiles deployed in silos carried 10 warheads. These ICBMs were distributed among Dombarovsky-3 near Orenbourg (64), Kartaly-6 near Chelyabinsk (46), Uzhur-4 near Krasnoyarsk (64), Aleysk in Altai (30), Zhangiz-Tobe near Seminpalatinsk (52), and Derzhavinsk near Akmolinsk (52). Thus, 204 of these missiles were deployed on Russian territory and 104 in Kazakhstan.

The elimination base at Surovatikha, near Nijny-Novgorod, destroyed 32 missiles last year, but thus far has destroyed only 22 of the 44 due to be destroyed this year. Only 30 of the missiles deployed in Kazakhstan have arrived at the base. This delay has been observed by the American inspectors.

The SS-18 can be converted into Space Launcher 18K. Equipped with a third stage, it can place 4 tons in orbit at an altitude of 500 km and an inclination of 65°. This stage would be derived from the propulsion system of the Phobos probe. Built by NPO Lavochkin, it has a thrust of 2 tons and serves to launch the Tekos satellite. Another variant would use a stage of the SS-24 missile to place a payload of 800 kg in orbit at an altitude of 1,600 km, inclined at 90°. Built by Yuzhnoye, this stage is equipped with an RD-866 motor that includes a 500-kg thrust nozzle, and with sixteen vernier nozzles, each having a thrust of 11.8 kg. Still another variant is under study with a view to using the C5M third stage of the Cyclone rocket for orbits at altitudes of 500 and 1,500 km. Also built by Yuzhnoye, it is equipped with an RD-861 (or 11D25) motor having a thrust of 8 tons. The 18K Launcher could be launched from Baykonur by 1996. The famous cosmodrome is equipped with 10 silos for the SS-18. Despite the efforts being made by Yuzhnoye to market the idea, however, no contract has been signed as yet, and Lavochkin's projects still lack financing (cf. AIR & COSMOS No. 1474).

Characteristics of the SS-18 and 18K

Characteristics	R36N Missile	18K Launcher
Number of stages	2	3
Height (m)	36.5	34.5
Diameter (m)	3.0	3.0
Weight (t)	211.1	210
1st Stage		
Height (m)	22.3	22.3
Weight (t)	161.5	161.5
Thrust (t)	460	460
2nd Stage		
Height (m)	6.8	6.8
Thrust (t)	77	77
3rd Stage		
Thrust (t)	/	2.0
Payload		
Height (m)	7.4	5.2
Weight (t)	8.8	4.0

Comparative Assessment of Effectiveness of Data From ERS-1, Almaz and Landsat-TM Satellites for Documenting Tundra Ecosystems

947Q0157A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 94 (manuscript received 9 Feb 94) pp 44-52

[Article by G. I. Belchanskiy, G. K. Ovchinnikov, V. I. Shevchenko and D. Douglas, Animal Evolutionary Morphology and Ecology Institute imeni A. N. Severtsov, Russian Academy of Sciences, Moscow; Alaska Fish and Wildlife Research Center, Anchorage; UDC 528.854.4: 581.5]

[FBIS Abstract] The comparative effectiveness of data from the ERS-1, Almaz and Landsat-TM satellites is analyzed with the objective of developing an integrated database for satellite and surface data, for classifying vegetation and documenting the parameters of tundra ecosystems, as well as choice of an optimum set of initial and synthetic channels for many-sided data processing. The integrated database for the geoinformation system includes data for certain limited areas in Alaska (three experimental sectors each of about 21 km^2, broken down into 8584 uniform landscape units, all sorted into 23 classes). Algorithms and programs were written for the many-sided processing of data using a classification optimality test: a minimum of the loss function in the case of a spurious classification. A step-by-step discriminant analysis of data was made for selecting the optimum set of principal and synthetic channels. A full-page data processing and classification block diagram is given. The results of the classification and comparative analysis are presented. It is shown that although the Almaz and ERS-1 systems are considerably less efficient than those of the Landsat-TM when classifying vegetation types, they nevertheless ensure systematic all-weather observations of other components of tundra ecosystems even during the polar night. The joint use of Almaz and ERS-1 data makes possible an increase in data classification effectiveness (because two polarizations and different wavelengths are used). Possible ways to further enhance this effectiveness are listed. Figure 1; references 14: 6 Russian, 8 Western.

Accuracy in Automated Geographical Referencing of Meteor-3 Satellite Digital Meteorological Information

947Q0157B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 94 (manuscript received 9 Dec 93) pp 62-68

[Article by A. P. Trishchenko, All-Union Hydrometeorological Information Scientific Research Institute-World Data Center, Obninsk; UDC (551.507.362:91): 681.3]

[FBIS Abstract] An evaluation of the accuracy in automated geographical referencing of data from the Klimat scanning photometer (10.5-12 μm; scanning angle +/-48° from the vertical) carried by satellites in the series Meteor 3, 4 and 5 in a global scanning mode is presented. A special data display subsystem has been introduced at the Scientific Research Institute of Hydrometeorological Information-WDC for checking the accuracy of geographic referencing. This was used in constructing satellite images in different geographic projections and in performing other important functions. The accuracy in determining the position of subsatellite points, accuracy of satellite clocks and measuring sensors are examined in detail. Theoretical and real accuracy evaluations are compared. The mean position accuracy of an image pixel for these three satellites was 5.0 km and the standard deviation was 2.7 km. The referencing accuracy for the Meteors 3, 4 is approximately half the size of an individual image pixel. A systematic banking angle deviation of - 29.1' was detected for the Meteors 3, 4, 5 which can be eliminated during processing (very small banking and yawing errors can be neglected). The findings are indicative of overall good stability in operation of space platform stabilization on these satellites. All these data were compared with data from such satellites as the NOAA 9, 10 and ja comparable accuracy was found. Figures 2; references 14: 8 Russian, 6 Western.

Monitoring Atmospheric Pollution Using Data From a Territorial Space Survey

947Q0157C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 3, May-Jun 94 (manuscript received 31 Jan 94) pp 84-91

[Article by I. M. Yegorov, L. P. Volkotrub and A. M. Korikov, Tomsk State Academy of Control and Electronic Systems; UDC 528.8.04:502.34]

[FBIS Abstract] A method is proposed for evaluating the atmospheric pollution level on the basis of the anomalous optical contrast on photographs taken in the near-IR range from natural resources satellites. A computerized monitoring technology was applied using a PC; in an interactive mode this makes it possible to carry out multifunctional joint processing of false-color images of an area and maps of the computed fields of near-surface atmospheric pollutants. The possibilities of using the developed programs are illustrated in the example of aerospace monitoring of a Siberian industrial center with ecologically dangerous enterprises making use of photographs from the Cosmos 1939 which carried multichannel medium-resolution (MSU-SK) and high-resolution (MSU-E) scanning instruments. High-resolution photographs, with resolution on the ground 40 x 40 m, are most suitable for regional monitoring purposes; medium-scale images correspond to a resolution 175 x 175 m. Work with the latter considerably increases the required programming and other work involved, but there are great masses of such photographs available. Further work along these lines will make it possible to collect image statistics and to define stable seasonal foci of anomalous contrast. By supplementing

the working cartographic material, including with use of high-resolution space survey data, it will be possible to increase the quality of spatial selection of features and the reliability in identifying anomalous contrast foci. The simultaneous use of medium- and high-resolution images is promising. The combining of information is not difficult due to the presence in the database of a conjugate map of sampling points. This makes it possible to carry out joint processing of space images with any field retrieved by the methods of spatial interpolation of point measurements. The developed procedures make it is possible to construct an integrated cartogram based on ecological monitoring of an area. Figures 4; reference: 1 Russian.

History, Current Projects of TSNIIMASH

947Q0172A Moscow SCIENCE IN RUSSIA in English No 2, Mar-Apr 94 pp 15-19

[Article by Yuriy Kolesov: "TSNIIMASH: The Cryptic Designer"]

[FBIS Transcribed Text] Some 20 kilometers out of Moscow, next to the highway connecting Moscow and Yaroslavl, stands the world-famous Space Mission Control Center. Few of its numerous visitors today know, however, that the Center is but a branch of the Central Engineering Research Institute (CERI, or TSNIIMASH), its Russian acronym), the largest in the industry.

Its parent institute, christened NII-88 of the USSR Armanents Ministry, was set up in May 1946, on the premises of the suburban Ordnance Plant 88, as the head facility coordinating the nationwide research, designing and manufacturing efforts to develop liquid-propellant rockets.

In the fall of that year, testing grounds were added to the Institute—one of them on the secluded Gorodomlia Island in the middle of the Lake Seliger, northwest of Moscow, and another—outside Zagorsk (recentlyl given back its old name of Sergiev Posad), about 70 kilometers from Moscow. A few months previously, Sergei Korolyov (1907-1966), the future academician celebrated around the world, was appointed Chief Designer of long-range guided ballistic rockets at NII-88 by order of the Armaments Minister.

A mere two years later, the first Soviet guided rocket, R 1, was launched with a signal success. Soon, the peaceful modifications of this weapon lifted research instruments and some living organisms to altitudes of up to 100 km.

Another success was scored in 1950, when a long-range ballistic rocket, R 2, covered a distance of 600 km. The Institute's staff continued research, coming up with improved intercontinental rockets, R 11 and R 7, the latter—the famous multistage Seven that went on to become the first space-age carrier vehicle. Actually, most of the credit for this accomplishment went to the Special Design Office (SDO), a CERI division.

In 1955, the Institute's staff started work on ballistic rockets launchable from under water. The project was activated by the invention made by the 88's chief engineer, V. Ganin. In the following year the Government took the momentous decision to have an artificial Earth satellite designed and launched by an R7-based carrier rocket sometime in 1957. SDO was chosen to coordinate the project.

By that time, it had acquired all the trappings of a full-scale self-contained outfit and detached, together with the rocket-making plant, from NII-88. Today, we know it as the Energiya R&D Association proudly bearing the name of its founding father, Sergei Korolyov. Over the past few decades, the institute has launched numerous research and design institutions on a life of their own. For example, the Chemical Machinery Design Office, which was led out of the CERI by the celebrated rocket motor designer, Academician A. Isayev (1908-1971), and several major R&D associations in the field of measuring equipment and composite materials.

The Institute (the title SDO acquired in 1967) continues to spearhead the nation's space research effort (following the abolition of the USSR Ministry of General Engineering, it was placed under the Russian Space Agency).

To make the Institute more manageable, its research divisions and branches were merged into research and engineering centers engaged in studies of heat transfer, structural strength, air and gas dynamics, and space vehicle mission control. To illustrate just how strong the new centers are brain-wise, the Heat Transfer Center alone employs 60 doctors and candidates of sciences out of its total payroll of 350.

Like so many other enterprises in the military-industrial complex, the Institute has, until recently, been a closed shop—for all outsiders. It was only last year, for the first time in the Institute's history, that its director, Academician Vladimir Uktin, invited a large group of journalists for an in-depth briefing and a familiarization tour around the Institute.

It would be a hopeless undertaking to tell about all the research projects under way at the Institute in this journal. We have picked only two, not because, we emphasize, they hold any priority over the rest, but just for lack of space. Still, the project we discuss below raised a furor at the International Aerospace Show in France in 1993.

Mockups Under Fire From a Gas Gun

The age of battleships, which came to a close with the end of the Second World War, came briefly back to life again in the early Eighties when the U.S. Navy bombarded the Lebanese coast. Everybody was astounded by the enormous destruction caused by the monstrous shells battleship guns. Guns of this type were, of course, produced in Russia for the needs of its navy and coastal batteries. No one involved in the ordnance industry hardly imagined that its output could ever be used for civil purposes, scientific research at that.

This is actually the case now, however—the world's biggest gas dynamic unit presently owned by the Institute has as its main component a string of gun barrels fitted end to end to form a 45 m bore 0.46 m in diameter receiving a piston-like projectile weighing 1.5 tons. Analogy with an ordnance piece could be continued even if gunpower were replaced with gas compressed to 300 atm, capable of pushing the piston at up to 200 m/sec. Appropriately enough, the staff call the affair the Gas Gun.

Now, in contrast to the real projectile, the Gas Gun's piston is not ejected from its barrel, but is halted at the other end of the barrel by a resilient cushion of another,

working gas compressed by the piston. The compression then goes on through a series of chambers separated by specially designed control valves operating within a few thousandths fractions of a second. The multi-stage method and unit development at the Institute have won it more than 120 patents.

Once the gas constrained under 2,000 atm at several thousand degrees is released through a shaped nozzle into an experiment chamber housing a flying machine mockup, it sets off a controlled explosion, as it were. Although it lasts from a few tenths of a second to several seconds, this time is enough to take multiple measurements of every aspect of the processes occurring on and around the mockups. Foreign models designed for this purpose provide a measurement time of only a few thousandths of a second, patently insufficient for comprehensive research.

This explains why the Institute has in recent months become a mecca for visiting delegations from many foreign space research centers, no doubt full aware of the fact that all Soviet hypersonic vehicles, including the *Soyuz* and *Buran* spaceships, are anxious to use the unrivalled units to test their future vehicles, too. In particular, they pin their hopes on the entirely new class of vehicles equipped with hypersonic air ram jet engines—aerospace planes which are currently on the drawing boards across Europe and in the United States.

The future vehicles will fly a large leg of their path in the upper reaches of the Earth's atmosphere, where they will be exposed to extreme dynamic and thermal stresses. For example, the German spaceship called *Senger* to honor the famous rocketry pioneer comprises two recoverable winged stages—a booster and an orbital vehicle. Its powerful engines accelerating it to seven times the sound velocity, the booster carries a smaller aircraft, the orbital stage *Horus*, riding it piggy-back. At an altitude of about 30 km *Horus* separates from the booster and continues on its way up into orbit, while the carrier aircraft returns to land on a regular airship. Incidentally, designers plan to make it a prototype for a supersonic liner capable of hopping, with hundreds of passengers on board to a distance of nearly 15,000 km.

Senger was the second mockup, after the minuscule replica of the French space shuttle *Hermes*, to have been tested in the Institute's gas-dynamic tunnel. Next, it seems, will be the futuristic NASP winged spaceship of the United States—at least the overseas designers are exhibiting a lively interest in the Russian experimental facilities.

Besides the multi-purpose array of gas cannon, the Institute researchers boast a mighty high-pressure jet generator that is used to simulate the specific flow of white-hot gases ejected from launch vehicle engines around their own tail structures. Some time back, the generator was used to study the liftoff conditions of *Energiya* rockets, the world's pace-setters, and the N1 rockets designed for Moon-bound manned missions, so far put off indefinitely.

Aside from catering to the aerospace industry, gas guns can fill many needs of fundamental science and industrial technologies. The mixtures they use for expanding gases, including carbon monoxide and dioxide, can be used to produce a gas-dynamic laser of unparallelled power or an intensive flux of ultraviolent radiation.

Another future-oriented technology is the so-called thermal gas synthesis which stands for a programmable combination of radiation, mechanical and heat pulses directed by a gas gun against test materials to harden the surfaces of mechanical components 1X1 mm or to provide them with various functional coats, and besides to launch the production of metal ceramic powder and articles made of them.

The Institute has joined forces with some other research institutions and industrial firms to develop—very soon, it is hoped—relatively small stationary and mobile gas guns for industrial applications. The mobile gun varieties can, for example, be helpful to oil rig operators and prospectors in cleaning rapidly and efficiently, using controlled explosions, oil pumps and interior surfaces of drill pipes.

Outer Space Transplanted to Earth

"The first thing I saw through the porthole was smoke, and then fire. Net, the whole world turned into a fiery white. Our vehicle was plummeting through raging flame. Molten metal spilled over the porthole glass... The outside temperature around the front end of the spaceship reached a staggering three thousand above zero! We have, in fact, turned into a giant meteor trailing a long tail." In so many words, Alexei Leonov, the first man to limber up beyond the cramped confines of his spaceship, described his plunge from orbit back home and, being a fairly good artist, drew it in color. It really looked like a bolide tearing up the Earth's atmosphere.

All returning astronauts confirm this impression. The outboard drama leaves no one indifferent. Even reposing peacefully on the ground, the singed descent capsule inspires awe in onlookers. Still, the people huddled inside their space cocoon are as safe as safe can be—protected by layers of heat-resistant and heat-absorbing materials covering the spaceship on the outside.

These materials are tested at the Institute, on a high-frequency plasma generator producing a heat flow of unique power. Built over a decade ago it is still the only thing of its kind in this country and elsewhere.

Its cube-shaped test chamber, approximately a meter at the side, creates for the reduced-scale mockups an environment very much like the real setting confronting the full-size spaceships entering the dense layers of the atmosphere. The air flows around them at Mach 2.5, at temperature ranging from 3,000 to 10,000°C.

To have the experiment conditions fully imitate the natural scene, the air injected into the chamber is first turned into plasma. To this end, it is passed through an ionizing quartz tube carrying a coil to generate a high-frequency electromagnetic field.

This preparatory stage has become a real stumbling block for Western researchers, one which compels them to replace natural air with inert gases in units of similar power.

The *Buran* space shuttle owes its safe return to Earth from its space mission, this country's so far only go at a reusable vehicle program, to the Institute's plasma generator—the black and white tiles that turned *Buran's* descent through the most dangerous section of its downward path into a pleasure ride had been tested in its heat chamber. The plasma generator studies preceding the real flight were so careful that they even allowed for a possible fouling of *Buran's* heat-resistant surface with bird droppings. The researchers had the "fouling agent" imported from Kazakhstan to faithfully reproduce the launch conditions on the site in Baikonur located in that republic.

Buran's triumph and the lack of its own facilities of this kind, encouraged the famous aerospace firm of Dassault, France, to contract the Institute for an equally searching testing of heat insulation for the *Hermes* winged spaceship, presently under construction.

Testing space-bound materials is not the only job the plasma apparatus can do. It also provides an ideal testing ground for structural material under extreme conditions. Or its gas jet can be used in diverse machining processes, for example, in spraying very fine coats of various materials on to the surfaces of complex components, or covering TV tubes with a perfectly smooth coating.

Career of Vladimir Utkin

947Q0155A Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 94 pp 45-50

[Article by Yu. V. Biryukov, head, historical section, Central Scientific Research Institute of Machine Building: "Seventieth Birthday of Vladimir Fedorovich Utkin"; the first paragraph is an introduction]

[FBIS Translated Text] Whereas between 1903 and 1912 K. E. Tsiolkovskiy was the sole scientist known throughout the world who had published studies in the field of scientific cosmonautics, in the two decades which followed several serious successors appeared on the scene: R. Esnault-Pelterie, R. Goddard, W. Homan, Yu. V. Kondratyuk and F. A. Tsander. Although the number of specialists in this sphere of activity, then becoming involved in developing rocket, rapidly increased, it can be definitely stated at once that there were only two leaders: S. P. Korolev in the Soviet Union and W. von Braun in Germany, and then in the United States. Great numbers of noteworthy scientists and designers grew up around them, many of whom headed and developed their own directions in rocket-space technology. Most of them have already left this world, but they had trained successors to replace them. Today it is difficult to name the single one most outstanding among these many illustrious scientists in the cosmonautics field, but...

Background of Career of V. F. Utkin

"Transport is the basis for conquest of the universe," stated K. E. Tsiolkovskiy. "The first great step of mankind is to fly beyond the atmosphere and to make an earth satellite. The rest is relatively easy, up to and including traveling beyond our solar system." The 36 ½ years of the space era which have elapsed, including 33 years of manned flights into space, have fully confirmed these ideas of the founder of cosmonautics. To be sure, the most complex event, the most staggering to the imagination of contemporaries, was the launch of the first artificial celestial body—our "Satellite," and then the unexpectedly rapid launch of the first manned spaceship, when a Russian man, Yuriy Gagarin, became an earth satellite. After these attainments, achieved due to the unique capabilities of the R-7 multistage ballistic rocket, developed by the experimental design bureau OKB-1 under the direction of S. P. Korolev, the first of an extensive family of boosters, including the Sputnik, Vostok, Molniya, Soyuz and the Rus, which has now been developed. The rest, in actuality, was relatively easy. Space activity rapidly grew in breadth (with respect to the diversity of spacecraft and their functions) and in depth, already taking in not only all of circumterrestrial space and landing on the moon, but also embracing all of circumsolar space from 43 million kilometers from the solar surface to the boundaries of interstellar space. It could have been developed still more successfully if there had not been economic and ecologic restrictions imposed on it by the level of development of space transport systems.

One of those who, overcoming these restrictions, made a major contribution to the development of boosters of the last generation was V. F. Utkin, academician of the Russian and Ukrainian Academies of Sciences. This scientist for a long time headed OKB-586 and the Yuzhnoye Scientific Production Association at Dnepropetrovsk which grew up on its basis and he now heads the Russian federal scientific rocket-space center—the central scientific rocket-space center of Russia—the Central Scientific Research Institute for Machine Building of the Russian Space Agency at Kaliningrad in Moscow Oblast.

The outstanding contribution of Vladimir Fedorovich to the development of rocket-space science and technology is indicated by his official state and scientific awards, degrees and titles. These awards were for the enormous work and specific achievements of Academician V. F. Utkin.

Landmarks in the Life of V. F. Utkin

Vladimir Fedorovich Utkin was born on 17 October 1923 in a large Russian peasant family in Pustobor village, Yerakhtur Rayon, Ryazan Oblast, only 30 km

from Izhevsk, where 66 years earlier K. E. Tsiolkovskiy had been born. His childhood and youth were passed in the worker's settlement Lashma, where his working father had found a job at a pig iron casting plant, and in Kasimov city, where Vladimir studied in middle school No 2. From his early years, like all his brothers and sisters, he was accustomed to difficult agricultural work, with equal stubbornness working away with a scythe, axe and shovel, distracting himself with model airplanes, skiing and fishing (their native home stood directly on the banks of the Oka, on a backwater). He completed school with distinction and dreamed of the profession of aviation designer, then the most prestigious. The war, which had started, disrupted these plans. Called into the army several days after his graduation, Utkin completed the courses for military telegraphists and chanced to serve in the air force, in the 49th separate company of the 278th Siberian fighter aviation division of the reserve of the Headquarters of the Supreme High Command, with it traveling the route from Volkhov to Berlin. The young commander was awarded two military orders of the Red Star and a number of medals for his courage and bravery on the fronts of the Great Fatherland War.

After the victory Vladimir Fedorovich decided to devote his life to the development of new military hardware and enrolled at the Leningrad Military-Mechanical Institute in the Rocket Armament Faculty. Combining his studies with design, and as we now call it, managerial work—obtaining orders from industry for the institute—he acquired not only rich knowledge, but also important engineering experience. Utkin underwent his prediploma practical work in Kaliningrad, near Moscow, which already then had become the unofficial capital of national rocket technology, at the Jet Armament Institute of the Ministry of Defense (NII-4), to which he was assigned for work, in 1952 receiving a diploma as a mechanical engineer. But the tasks delegated to him there and the clearly auxiliary role which was afforded the civilian specialist in the military organization made him uncomfortable and with satisfaction he accepted a transfer to the newly established SKB-586 at Dnepropetrovsk, where from scratch he worked on organizing standard production of the R-2, the best rocket of that time, developed in the OKB-1 of S. P. Korolev. V. S. Budnik, the SKB chief designer, rapidly noted the broad engineering competence of the young specialist and his organizational skills. He immediately won authority at the SKB and independent responsible work began to be delegated to him.

These years, perhaps, were the most stressed in his life (for months he had to work for 14-15 hours a day), but it was precisely they which hardened him and predetermined the success of all his subsequent activity. It is a fact that at that time organizers and directors were not specially trained in the country and engineering training at higher institutions of education was not adequate for performing such functions. Accordingly, in order to shape young directors (to be sure, those having the necessary technical knowledge and creative talent) work experience with people along Party and Komsomol lines frequently became decisive; in scientific and design groups this leadership was not so much of an ideological-bureaucratic character as it was directed to raising the level of management-labor relations.

An experimental design bureau headed by M. K. Yangel was organized in 1954 on the basis of the SKB, in which Utkin, as an already experienced specialist, immediately began to play a substantial role. In 1961 at age 37 Utkin became a deputy, and in 1967—the first deputy of the chief designer. At that time M. K. Yangel had already long been severely ill and the responsibility for design bureau work gradually began to fall more and more on the shoulders of the first deputy. It is therefore probable that after the death of the chief designer the question of who would head the enterprise was answered almost automatically. Utkin did not undertake any fundamental restructuring; on the contrary, he strove to continue the well-organized work of the design bureau and all the enormous cooperation with subcontractors, strengthening the traditions which had been established.

During the 19 years of work under the direction of V. F. Utkin the NPO Yuzhnoye developed and constructed the world's best intercontinental missiles of different classes, considerably superior to American missiles. And it is not by chance that the chief objects of attack by the Americans in the negotiations on the limitation of strategic armaments was the SS-18 heavy liquid-propellant missile (for which the United States had no equal), which is capable of inflicting blows at any point on the globe from any direction and the capability of defeating any antimissile defense system, including the SDI, and the still more modern mobile-based SS-24 solid-propellant missile.

Contributions of V. F. Utkin to Space Industry

The OKB-586, organized for producing missiles, after the R-12 constructed the R-14 missile with twice the range, up to 4000 km, after which it was faced with a still far more complex task: proceeding to the construction of the R-16 intercontinental missile on these same principles. It, as conceived by the client, with equal technical specifications with respect to convenience in operation, should be superior to the R-9, the new oxygen-kerosene missile produced by OKB-1. It would seem that with such assignments the young design bureau would have no time to think about anything else, but the times called for its working on space projects....

When it became evident that small satellites would have advantages over large satellites for solving many scientific and defense problems and that it would be wasteful to launch them with the R-7, planning-design development work on them was transferred from OKB-1 to OKB-586, which once again was faced with the task of developing a light and the least expensive possible booster. A task which was successfully solved in March 1962 by the construction of the Cosmos booster with the R-12U as the first stage and with a new second stage. The

designing of the booster and a very simple "satellite" (the DS-1) was carried out under the direction of V. M. Kovtunenko. However, the subdivisions headed by Utkin developed its design, giving particular attention to reliability and the safety in handling it. This undertaking for a long time became the most important challenge to the creativity of Vladimir Fedorovich because he was personally assigned the task of storage of ready-to-launch strategic missiles, that is, charged with liquid fuel components extremely aggressive to all materials, for a period of five or more years. The United States also tried to solve this problem for the Titan II ICBM, but after the catastrophes which occurred this was deemed to be unrealistic and a changeover to solid propellants was made for all strategic missiles. We, however, succeeded in solving the problem by drawing into the work a great number of academy and departmental scientific research institutes and design bureaus in the metallurgical, physicochemical, chemical and other fields of specialization. The research involved the physics of the flow of gases and fluids in microcapillaries, inter- and intracrystal corrosion and the influence of the composition and quality of materials on their permeability. Methods were developed for experimental research and computations, the standards for airtightness were set for different materials and fuel components, specifications were defined for metallurgical semi-finished goods and production technology, for testing and checking of fuel tanks, lines, valves and other hydraulic fittings, as well as intratank measuring devices. At this time it was virtually impossible to find Vladimir Fedorovich in his office. He was always in the place where it was necessary to make the next decision determining the further course of the work: in laboratories, workshops, at test sites, day and night, on workdays and on holidays. No one could understand when he rested: both in a hotel and on a train and in an airplane he always was surrounded by fellow workers, he listened to one, he gave instructions and advice to another and tried to convince a third. And the considered problem, like many others which were no less complex and were solved in entirely realistic times....

A special concern of the general designer was the relationships with clients, because it was they who governed which of the promising OKB projects supported by the research of the Central Scientific Research Institute for Machine Building had a possibility for implementation. They received the "right to life" after flight tests, whose direction was a highly important aspect of the many-sided activity of the general designer of rocket-space complexes, surpassing in degree of responsibility and stressing of all spiritual and physical forces that of all other aspects taken together. Test launches were the end result of many years of persistent and purposeful work of many tens of thousands of specialists not only of the main OKB and the actual builder (usually the Yuzhniy Machine Building Plant Production Association), but also of enormous cooperative efforts throughout the country. The next step of the Dnepropetrovsk people into space was the construction of a booster based on the R-14 rocket, which in open publications was called the Intercosmos. This booster turned out to be successful and beginning in 1964 successfully put into orbit many Dnepropetrovsk and Krasnoyarsk satellites with a mass up to 1 ton.

In the early 1960's S. P. Korolev proceeded to the organization of a new grandiose rocket-space system based on the N-1 superheavy booster (ZEMLYA I VSELENNAYA, No 4, p 62, No 5, p 77, 1993), whose first task was to become the implementation of a lunar expedition. He assumed that this program had to become an undertaking for the entire branch. He hoped that M. K. Yangel and his group would take on the development work for all the rocket units of the orbital part of the system (they had a preliminary agreement on this). But at the last moment, citing an overload with defense orders, M. K. Yangel took on only development work on the rocket part of the lunar ship, and the Dnepropetrovsk people must be given their due, they handled this task beautifully. And although B. I. Gubanov was directly responsible for developing the design of rocket unit "Ye," and I. I. Ivanov was directly responsible for its engines, V. F. Utkin, the first deputy of the chief designer, also had to be concerned with the construction of this unique vehicle, which during 1970-1971 underwent successful flight tests in circumterrestrial orbit as part of the experimental T-2K ship.

Korolev counted on the broad participation of the Dnepropetrovsk group in the lunar program, which certainly would have facilitated its more successful implementation. But on the insistence of the chief developer of powerful liquid-propellant engines, Academician V. P. Glushko, at that time encountering serious difficulties in developing oxygen engines, not having been successful in developing nitrogen tetroxide engines (S. P. Korolev was a categorical opponent of their use for heavy boosters), M. K. Yangel decided to develop the project of his R-56 heavy booster, an alternative, like the Chelomey UR-700, to the N-1 project. Unfortunately, nothing came from this competition other than a dissipation of energies which was far from state interests.

The Yuzhnoye Special Design Bureau, returning to its fundamental principles for developing boosters on the basis of military missiles, attained new success. This made it possible to construct boosters with minimum expenditures of time and money. A reduction in costs was attained by using in the booster the stages of military missiles after they were taken out of service or out of storage after the elapsing of their guaranteed useful life with appropriate repair or reworking. In 1972 the SS-9 two-stage ICBM, capable of putting a payload up to 3 tons into a reference orbit, was adapted from a two-stage booster by means of relatively small further improvements. In addition to improving this booster, transforming it into an outstanding achievement in engineering thought, the SS-18 heavy ICBM, the booster called the Tsiklon, based on its rocket units, continued to be improved.

With a launch mass of 188 tons the Tsiklon booster, put into use in 1980, became capable of putting a payload of 4 tons into a reference orbit. But it was not this which constituted its qualitative advantages in comparison with all which had been constructed earlier. In the Tsiklon rocket-space complex, whose launch pads were constructed at the Plesetsk cosmodrome, safety in preparing the rocket for launch, for which V. F. Utkin always strove, was raised to the limit. With respect to the degree of mechanization and automation of all the work, with a total absence of personnel at the launch complex, the Tsiklon had no equals in all of world rocket-space technology. After direct assembly of the rocket-space system, including the rocket units of the three stages, the spacecraft and the nose cowling protecting it and the third stage in a horizontal position on the railroad transport-erection complex, it was delivered to the launch pad where all subsequent technological operations were carried out in an automatic mode: erection in a vertical position and connection of all the electrical, pneumatic and hydraulic lines of the rocket with the stationary lines at the launch facility, its aiming, charging with fuel components and launch. The control of operations and the checking on their implementation was done using an automated control system with a digital computer using a special cyclogram in standard time coordinates. This ensured Tsiklon launches at a precisely stipulated moment during any season of the year and time of day under any meteorological conditions with a wind speed at the surface up to 20 m/s. The highly precise rocket control system and the multimode engine of its third stage made possible the precise putting of a payload up to 4 tons into various circular and elliptical orbits with perigee altitudes from 200 to 3000 km and an apogee from 200 to 8000 km. All these qualities enabled national cosmonautics to reach a new stage: a changeover from individual, although frequent spacecraft launchings to permanently operating orbital groupings for defense and economic purposes.

The next step in the development of national transport space systems became the development of their standardized series in conformity to a a unified plan with the participation of the principal rocket building enterprises.

A new two-stage booster designed by V. F. Utkin, the Zenit-2, became the first in this series. Launching up to 13.8 tons into a reference orbit with a launch mass of 459 tons, it belongs to an intermediate class. After the failure in constructing the N-1, the Zenit was the first national booster developed specially as a space transport system for putting automatic and manned spacecraft of different types for different purposes into orbit. It was developed on the basis of the universal rocket unit of the first stage of the Zenit-1, jointly designed by specialists of the NPO Yuzhnoye and NPO Energiya. The world's most powerful oxygen-kerosene liquid-propellant engine, the RD-170, with a thrust 740-806 tons, was constructed for this purpose. With a diameter of 3.9 m and a length of 33 m the unit has a launch mass 353 tons. The launch mass of the second stage of the Zenit-2 booster is 90 tons with a length of 11 m and the same diameter.

The construction of the Zenit booster, becoming the most modern rocket in its class, is of very great importance not only in itself, but also as a stage for constructing the superheavy Energiya booster. The Zenit-1 universal unit, having undergone a full cycle of development work, surface and flight tests as part of the Zenit-2 booster beginning in 1985, later in the form of four lateral units was used as the first stage of the Energiya booster. The Zenit and Energiya launch facilities used the same principles of full mechanization and automation which were used for the first time in the Tsiklon. The succession of work by the Dnepropetrovsk and Kaliningrad groups exerted an influence on the transfer of B. I. Gubanov, Utkin's deputy, to the NPO Energiya. Gubanov became the chief designer of this very powerful rocket, making successful flights in 1988 and 1989. Vladimir Fedorovich himself, however, whose scope of activity had long before gone beyond the bounds of a single, be it the largest and leading NPO, since 1990 has headed the key scientific institute of the Russian Space Agency—the Central Scientific Research Institute for Machine Building, made up of an ensemble of scientific centers developing virtually all theoretical and experimental aspects of rocket-space science, including control of space flights and the working out of the federal space program of Russia.

Gloomy Picture of Conditions at Leninsk Presented

947Q0153A Moscow ROSSIYSKIYE VESTI in Russian 19 Jul 94 p 5

[Article by Yuriy Konorov: "Russia Leased the Cosmodrome From Kazakhstan..."]

[FBIS Translated Text]

Divvying up

An agreement was ratified in Almaty recently between Kazakhstan and Russia regarding the lease of the Baykonur Cosmodrome. Whether it will help to preserve that unique manmade creation, time will only tell. After all, time is money, which the domestic space sector needs badly today...

It all began with that edict issued by Nursultan Nazarbayev, on the basis of which all the enterprises, organizations, and facilities in Kazakhstan were placed not only under the jurisdiction of the Republic of Kazakhstan, but also under the state control of that republic.

A perfectly natural question came to mind: why, specifically, should something that was built by 15 republics belong to just one? And if the other republics swallowed that announcement, Russia, who had invested no small amount of money in the creation of the "space port," didn't care to accept the decision. And soon after, the commander of the Military-Space Forces of the Ministry

of Defense of the Russian Federation, Lt. Gen. Vladimir Ivanov, answered in a crisp, military manner: "The launch facilities will not be removed from the jurisdiction of the space units."

And that is when the process of the very intricate, delicate adjustment of relations "got under way." After all, at issue are an immense amount of physical assets, dozens of specialists, and all our former republics, not to mention general science, security, and defense.

After some very trying arguments and fatiguing debates, the basic tenets were finally worked out:

1. The Republic of Kazakhstan and the Russian Federation are to pursue a coordinated policy aimed at expanding collaboration in the study and use of outer space and at further developing the Baykonur Cosmodrome for the purpose of implementing national and international space programs, as well as commercial space projects.

2. The Baykonur Cosmodrome must be maintained as a facility that is of especial significance to the performance of the civilian and military space programs of Russia and the Commonwealth as a whole.

A method was finally found to preserve that archimportant facility: Russia leases Baykonur from Kazakhstan for 20 years, with a subsequent extension of the contract.

They say that too many cooks spoil the broth. Experience shows that as soon as a business gets two owners, everything falls into disarray. There is no better confirmation of the truth of that observation than the history of Baykonur. While the higher-ups were trying to work out who would be the proprietor with full authority over it, the proper amount of money for its upkeep, as well as for the upkeep of the city of Leninsk, was not being appropriated.

Last year, for example, it was the military who was the most helpful and solvent. All the money for the preparations for winter was transferred on time to Baykonur through the military-space forces. About 140 million rubles [R] came from the Russian Space Agency, which was to have provided R2.1 billion. Only R510 million came from the Republic of Kazakhstan, which, by agreement, was to have provided Baykonur with R1.2 billion. Thus, the vital activity of Baykonur is being supported mainly by appropriations from Russia.

2. In the morning, money; in the evening, Baykonur?

The appropriations needed for the upkeep of the infrastructure of the cosmodrome and the city that sprang up in the bare steppe are not small. Judge for yourself: the central portion of the cosmodrome has two launch positions for the R7-A rocket, which placed the space craft carrying Yuriy Gagarin into orbit. Those launch positions function for the manned program—mainly for the program involving new observation systems created by the Samara Central Construction Design Bureau headed by D. I. Kozlov. At pad No. 45 are two launchers for the Zenit rocket, one of which exploded during flight-design tests of the Zenit, the other of which is still alive and is used for launching satellites. In addition, there are four launchers for the Proton, as well as launcher for the Tsiklon. There are also numerous facilities directly associated with the Energiya-Buran program, i.e., a universal launch complex, two launch positions for Energiya, and a huge complex of technical buildings, including the launch-vehicle tech area and the orbital-vehicle tech area. The cosmodrome's infrastructure also includes assembly-and-test buildings, fueling stations, and everything that is needed to prepare for the launches. Keeping all those positions in working order takes no small amount of money.

And there are no fewer concerns when it comes to the city of Leninsk. Not all that long ago, there were upwards of 130,000 people living in the city, occupying housing with almost a million square meters of floor space. In addition, Leninsk has three hotels, 10 schools, 28 kindergartens and daycare centers, a branch of the Moscow Aviation Institute, a technical school and a medical school, 14 refectories, 50 stores, five plants and meat processing centers, three tailor shops, a heat and power plant, a wonderfully equipped military hospital, a city polyclinic, hospitals, and more than 100 administrative buildings. There are also a multistory communications center, an officers' center, a movie theater, a children's and adolescents' art center, a sports complex with swimming pool, and much, much more that gladdens the eye against the backdrop of the dry steppe.

And all that also takes a proprietary eye and, alas, money. But if there was no shortage of claimants to ownership, there were far fewer of those willing to completely take over Baykonur with their own financial allowances. To be more precise, there were none at all. And everyone knows from simple schoolbook physics that any system that has no support will collapse from external forces.

3. And yet, the city will remain!

I must admit that, as I flew to the launch position of the Soyuz TM-19, I had a heavy heart. I was afraid that after my annual (compulsory) time away, I simply wouldn't recognize the city. Over those few months, my colleagues had painted a painfully gloomy picture of the city. "Goodbye, Baykonur," "The Collapse of Baykonur," "Nightmare at the Cosmodrome," "Baykonur: Back to the Desert"—those are just a few of the may headlines that appeared in domestic and foreign newspapers and magazines. What's more, even "foreign experts" had flown to the "space port"—representatives of the American firm Unser, messrs. R. Dalby and B. Alexander. After being there not even two full days and inspecting the launch and technical complexes for the Soyuz, Proton, and Energiya launch vehicles (30 minutes at each complex), the guests produced a more than optimistic forecast, announcing that the breakup of the

Soviet Union had no effect whatsoever on the capabilities of Baykonur. And all the myths about the collapse of the launchers and of the social sphere of Leninsk were for a very "prosaic" reason: the military wanted to "squeeze" a little more out of the state budget for their own personal needs.

I don't even want to comment on the honesty of such an evaluation by foreign "couriers." I'll just say that what is, in itself, remarkable, is that the space complex is "being evaluated" by foreign citizens. Our domestic specialists know full well how limited the access is to such facilities for Russian scientists.

Another transoceanic expert, Mr. Berlin, is more diplomatic about it: "Everything's OK at Baykonur, but there are 'no comforts' in Leninsk."

But how are things, really? I'm not even going to begin talking about the condition of the launch complexes. From what the head of the cosmodrome, Aleksey Shumilin, said, I got one thing: the launch crews today are operating according to the kolkhoz machine-and-tractor service station principle: out of three tractors you can get one. The reason is the same. There's not enough money or parts.

And there's not enough to maintain the city, either. And that's why the people are running out. They're leaving uncertainty and a higher crime rate. As of 1 July, more than 18,000 people had left Leninsk. And, unfortunately, more will leave. Overall, a total of 12,000 military specialists are slated to be left there. Mainly those who keep the military launch complexes in combat readiness. That's being done in such a way that, in the future, space-related jobs will be able to be handled by those very people. That is, of course, if the issue of "overtime pay" is settled. The work load will grow many times over, and, in any case, we know that many operations have to be done with mixed crews (because of the low staffing levels). And combat training is suffering, and the safety equipment is just barely acceptable.

People are leaving, tired of believing in the very "best" edicts. In order to ship their furniture, they have to get on a list three months ahead of time. But there still aren't enough containers. And so the furniture goes up for sale for a song. The city is pasted over with those "banners of a sad time": "For sale" and "Must sell." Things acquired with difficulty over the years go for next to nothing. And here's yet another ad, perhaps the saddest of all: "New baby bed for sale." With one line, people have scratched out any hope for the city. The garrison officers' center burned down this past winter. But "burned down" is not quite accurate. To be precise, it was set on fire, after all the windows were broken out: "for fun." Afterwards, it smoked for three days, like Fujiyama in Japan. But there'll soon be even more smoke in the city. The fact is that money is needed for preventive maintenance of the city's heat and power plant. The repairs should have been started today, because they're major repairs, and only four months are left before winter arrives. But the city authorities look upon all the visits by representatives of the city Duma and by the vice premiers with skepticism. And so it has definitely been announced to the city residents that they should "stock up on space-heating stoves and stock up on firewood! More than likely, we won't be able to finish the repairs on the heat and power plant." "Saving those who are freezing is a top priority..." In answer to the questions of the ubiquitous correspondents about what will happen to Leninsk, the "city fathers" say this: we will give up some of our accommodations, and live more compactly. But nature, alas, doesn't tolerate a vacuum. The freed-up, mothballed space will collapse. And that's not even the worst of it: what's much worse are what, in Russia, we call the bums. The process has already started: there is a complex crime situation in the city now. Settlers are arriving from the Aral region. Without any authorization, any passes, any work, any means of existence. Those people bunch up into criminal groups. They attack officers and warrant officers returning from the service, and they burglarize apartments whose inhabitants are away, working at the launch complexes. They steel bread from the local bakery and resell it, and they exchange Russian rubles for the national currency—the tenge—for a profit.

Everything is being sold. And it's being sold to everyone. That's clear when you understand that most of the stores are closed under the pretext of "repairs." But the real reason they're closed is something else: the huge customs tariffs on the import of goods that have nothing to do with space programs have devastated the shops.

Empty safes that nobody needs anymore lie around the empty, limed halls. Even the cockroaches have left. But the hotel is full of them, and some kind of strange mutant has showed up, bright orange, with long, high legs. Someone was saying that it's from America—but there wasn't anybody to be any more precise than that, inasmuch as none of our foreign colleagues flew here, because of the high prices for this flight (as well as, by the way, the series of flights before this one).

Even the shower unit with the hydrogen sulfide source has been terribly damaged by some unknown force: to break something, as we know, is not to build it—you don't put your heart and soul into it.

The city's sociological service conducted a survey of the city's residents: "Which would you rather see our city as: Kazakh, or Russian?" The response was unanimous: "We don't care, as long as there's order!" That's how the Russians and the Kazakhs answered, as well as the civilians and the military, and the young and the old. Because all of them are similarly tired of all the endless games in the "bright future," which, without a doubt, must come after the ordinary resident and laborer give their vote to one and refuse to believe in the other. The voice of the people is the voice of God, the ancients said. Fortunately, the understanding of those generally simple truths came from the popular masses and went to the strong of this world. Already, the hottest heads both in

Russia and in Kazakhstan have begun to understand that you can't divide the indivisible—i.e., that huge science complex called Baykonur. Alone, it would be impossible to operate that complex facility. And despite the assurances of an O. Bender, no sort of "abroad" can help us. And when the celebration of the victory speeches rang out, there was quiet recognition of those truths. That is why, despite the sad pictures of the young city of Leninsk, I left the place with a light heart.

International Aerospace Congress To Receive No Government Funding Support

947Q0159A Moscow SEGODNYA in Russian 4 Aug 94 p 9

[Article by Mikhail Chernyshov: "Big Circumspace Maneuvers in Russia. They Are Made Under the Slogan 'Seek a Sponsor'"]

[FBIS Translated Text] Two major aerospace events are planned for the same time beginning in mid-August. First all the cosmonauts and astronauts who have ever flown in orbit are to meet in Moscow. At any rate, initially the intent was precisely that, but in actuality it was impossible to implement this idea to the fullest. The International Aerospace Congress will be held a little later. It will be attended by the leading aviation construction companies, scientists and designers from 28 countries of the world. The two initially independent events, as visualized by their organizers, are naturally being transformed into a unified aerospace forum at which the world community of "sky dwellers" will discuss the problems which have recently accumulated.

The International Congress of the Association of Spaceflight Participants will be held during the period 8-16 August. "This is an anniversary event," declared Col. Gen. Vladimir Kovalenok, president of the Russian Association, to the newspaper SEGODNYA, "since it is now taking place for the tenth time. This time it will be held under the motto 'Space and Ecology.' Guests will arrive from 27 countries. Provisions are being made for the invited cosmonauts to take trips through the country and to speak at public gatherings. Plans call for an excursion to Baykal. The general purpose of the measure is to attract the attention of Russian governmental, as well as international organizations, including the UN, to the most acute ecological problems of Russia, such as the death of forests, pollution of water bodies and disappearance of valuable natural features. Major financial difficulties naturally arose. To the surprise of the organizers, government agencies failed to respond to all petitions for material support. Regional administrations, earlier promising collaboration, then, after the invitations to congress participants had already long before been sent out, suddenly balked. The event was in danger of collapse. By tradition hopes were laid on the responsiveness of commercial organizations.

"It is painful to Russia," laments Kovalenok, "that Mexico, having but a single cosmonaut, was worthily able to host a congress in that country. But the country in which there are already about eighty of them does not have that possibility."

"It is impossible to bring together all the exoplanetary space family, which now numbers more than 300, not only due to financial considerations. Many of the cosmonauts long ago departed from the space field. Moreover, in some countries, such as Afghanistan, Vietnam and Romania there are few who know that they have their own cosmonauts in their country. In its time the Soviet leadership assiduously put into orbit representatives of the countries with a 'socialist orientation,' but among the leaders of these countries themselves there were already completely different ideas concerning both orientation and the prospects for the development of relationships with the USSR. They did not need 'superfluous' proof of the inviolable friendship. Thus strange 'semianonymous' persons came to be. For example, the world knew that there was such a cosmonaut as Dumitru Prunariu; in Romania itself, however, the then-time authorities saw to it that no one in the republic would suspect that it had been granted such a high honor. Now the 'error' has been corrected. In addition, the cosmonaut has received the high post of Minister of Aviation. It hasn't gone that well with everyone, but the cosmonauts themselves, including the 'forgotten' ones, are continuing to keep up contacts with one another."

"We are expecting 300 persons," says Lt. Gen. Petr Klimuk, chief of the Cosmonaut Training Center. Approximately half of these will be cosmonauts and astronauts and the remainder will be family members, 'accompanying parties.' The largest delegation will be American: about 30. The guests will spend only a day at Zvezdnyy and then spread out through the country."

The International Union of Scientific and Engineering Societies, Russian Academy of Sciences, Russian Space Agency and other institutions are the organizers of the aerospace congress. The period for carrying out the measures is 15-19 August. Perhaps for the first time such a major event is not being funded primarily from the state budget, but instead is being supported by the sponsors. Banks and commercial organizations, while understanding that the congress cannot yield a rapid or any financial payoff at all, have nevertheless agreed to allocate monies to it. It is the opinion of Aleksandr Demakov, executive director of the congress, that definite advances are being made in a positive direction, a moving away from crass mercantilism, in the social, including in the "commercial" consciousness.

Practical problems, if nevertheless not predominating over "pure science" at the congress, at least will be on a par with it. Evidence of this is the striving to show goods in concrete form. The Russians, for example, intend to demonstrate to their foreign colleagues the latest aerospace and conversion products which are ready for standard production.

According to Professor Mark Liberzon, deputy chairman of the Russian organizing committee, all the leading

world aerospace organizations, including the national space agencies of Russia, Western Europe, United States, Japan and China, have agreed to participate in the congress. Taiwan will be represented by a separate delegation. Presentations by specialists from Kazakhstan and the Ukraine, which are intended to familiarize colleagues with plans for the development of the aerospace complex in their countries, are being awaited with understandable interest.

A total of more than 600 persons are expected at the congress. More than a thousand reports have already been sent in to the organizing committee.

Commentary on Moscow International Space Congresses

947Q0160A Moscow GUDOK in Russian 23 Aug 94 p 4

[Article by V. Kamyshev: "Leap From the Stone Age and Back. From the International Space Congresses"; the first paragraph is an introduction]

[FBIS Translated Text] Interplanetary space is becoming an indispensable part of the activity of those who live on our planet. The glances and thoughts of people in the most different fields of specialization, from scientists to businessmen, are turning more and more often to the heights beyond the clouds. As is well known, 1992 was declared the International Year of Space. A boom began on the construction of such space vehicles as the Ariane 5, Columbus, Freedom and others.

Russia remains the leader in this field despite all its economic difficulties. The year 1994 was declared the Year of the Earth's First Cosmonaut Yu. Gagarin. Two international congresses were organized in Moscow for the first time: an Aerospace Congress and a Congress of the Association of Spaceflight Participants. The leading scientists, developers of orbital vehicles, cosmonauts and astronauts (about 1500 persons) from 29 countries discussed the problems involved in further exploitation of interplanetary space on the basis of cooperation and mutual assistance.

During the short time of their work the participants in the two forums in a way again "spread out" the entire evolution of the world space branch.

I recalled an address of the American astronaut Edwin Aldrich, who a quarter-century ago, together with Neil Armstrong, for the first time in the history of mankind "strolled" over the moon, the eternal satellite of our planet.

"During these minutes," related Edwin, "we, people of the Earth, felt ourselves to be creatures of the unbounded space ocean, capable of any feats. Around us everything was surprisingly mysterious: unnatural stillness, odors, fantastic shadows. The thought arose that man had made a gigantic leap from the Stone Age. We rejoiced that we were the first to see and experience all this..."

Equally impressive were the stories of cosmonauts of the "Gagarin group" about their "walks" beyond the Earth's threshold. They were the first inhabitants of our planet who had the opportunity to feast their eyes on the beauty of our planet from orbit.

All this is a bygone stage. Today the emissaries from the Earth visiting interplanetary space, as well as scientists, declare that space is bringing people closer together, is orienting them on solution of the numerous problems of mankind. And we on this planet have advanced along this path. Even now more than a few well-developed countries are successfully achieving entry into orbit by means of one-time use boosters. However, rigorous requirements on reliability, the need for routine docking in orbit, the use of ecologically pure fuel components, and finally, the need for a sharp reduction in cost and simplification of the delivery of cargo into space, are becoming restraining factors in their use. Scientists in many countries have now concluded that it is necessary to develop multiply reuseable space systems with the partial or complete return of their principal structural units to the surface.

During the recess between the plenary and section meetings of the congress I discussed this theme with G. Lozino-Lozinskiy, member of the International and Russian Academies.

"Gleb Yevgenyevich, Russia remains in the lead in the new direction, construction of profitable multiply reuseable space systems. The proof of this is the construction of the Buran several years ago by the Molniya organization, which you headed. Due to financial difficulties it unfortunately 'bit the dust.' In such a situation does not the danger arise that our country will lose leadership?"

"Such a danger does exist. The most terrible thing is that we may lose the accumulated potential which is unsurpassed by anyone elsewhere in the world. And this includes highly qualified specialists, patriots who are now working, one could say, from enthusiasm."

"It must be hoped that the worst will not occur. On specifically what are Russian rocket builders working?"

"At the present time by no means all countries have an adequate scientific-technical and economic capability for independently implementing space programs. They see a possibility for their realization only within the framework of international cooperation. The results of the first attempts to construct multiply reuseable systems—our Buran and the American Shuttle—cannot be considered satisfactory. The cost of their construction and operation has been no lower than for vehicles used but a single time. In the 'post-Buran' era our scientists have oriented themselves on the development of multiply reuseable transport systems using an aircraft as the basis for their development. One of the variants of such a system is the MAKS—a two-stage multipurpose aerospace system in which the role of the first stage is played by an AN-225 heavy transport aircraft with a takeoff weight of 620 tons..."

At one of the section meetings a representative of the American McDonnell Douglas Corporation told of a recent development by that company—a multiply reuseable nonwinged vehicle with a conical configuration called the Delta Clipper. Its advantages include low-cost operation (in a single launch the saving is up to 10 million dollars), possibilities for takeoff and landing from a small concrete pad under any weather conditions, and outfitting with the latest electronic systems. According to the American designers, the Delta Clipper will afford new possibilities for superhigh-speed flight for any distance.

Such a transport system, as well as profitable space communication, is increasingly attracting the attention of even the poorly developed countries. Now the governments of Pakistan, Saudi Arabia, India and other countries are allocating great sums for the development of the space branch. For example, in 1993 all countries in the world allocated 25 billion dollars from budgeted sources. And commercial firms allocated only two billion.

An interesting discussion on this theme took place at a round table discussion session in the economic section. It was clarified that in contrast to foreign specialists, in Russia, where it is customary to live by orders from above, until now there are few who correctly understand the expression "commercialization of space." And this, in addition to purely market relations, licensing, insurance activity, involvement of commercial organizations, development of so-called dual- purpose technologies, conversion, etc. Until now we also have no law on the commercialization of space, which is very greatly restraining direct agreements between enterprises.

As noted by B. Katorgin, general director of the NPO Energomash, foreign specialists are coming to his association in an endless stream for gaining experience, are proposing the signing of contracts for joint work and the purchase of finished items. Because the rocket engines of this association are unequaled elsewhere in the world. All the rockets of our country are outfitted with them. And the probability of failures during launches is considerably lower in our country, for example, than is true for the Americans. But indeed, due to the low quality of electronic instruments and solar transducers the performance of our country's satellites, especially space communication satellites, is considerably lower than is the case abroad. As a practical matter with our enormous space potential this is but a detail. But no one, unfortunately, is concerned with the correction of this shortcoming. The support of the space branch promised by members of the government remains just words. Commercial organizations also are being cautious in investing funds in the space branch, not having hopes that in the immediate future it will emerge from the economic blind alley.

According to the assertions of American specialists, there are "buried trillions" in space. But in order to exploit them it is first necessary to invest a definite percentage of resources in the development of the space industry. In our country, however, this most highly promising branch was virtually kept in the background. As was expressed by G. Lozino-Lozinskiy, general director of the NPO Molniya, the present aerospace congress is the most troublesome. Russian scientists and designers, concerned with the preservation and multiplication of the accumulated potential, are sounding the alarm. There is an urgent need for financial support and new legislation.

The Aerospace Congress participants adopted a number of resolutions and issued appeals to the government. They feel that the stimulation of international cooperation in the aerospace field for the welfare of the world and progress and the organization of a World Aerospace Federation are the order of the day.

Khrunichev Organization Completes Work on Adaptation of Iridium Satellite

947Q0160B Moscow MOSKOVSKAYA PRAVDA in Russian 6 Aug 94 p 1

[Article by M. Kudryavtseva: "Space Communication"; the first paragraph is an introduction]

[FBIS Translated Text] The State Space Scientific Production Center imeni M. V. Khrunichev has completed work on the adaptation of American satellites for Russian boosters.

This is one of the principal stages in participation of the association in the international Iridium program for establishing a global telephonic communication system. The objective of this project is the organization of a qualitatively new communication system. The orbits of 66 artificial satellites, transmitting signals one to another, will completely girdle the Earth. And already after two years each of us will be able, without straining our vocal cords, to communicate by means of a pager not only with distant countries, but also with any corner of our motherland, which for the time being still, unfortunately, is quite touch-and-go.

Sixty-seven countries are participating in the international program. The Khrunichev Scientific Production Center owns 5% of the shares in the Iridium consortium, which amounts to 40 million dollars. This is one of the first cases when a Russian enterprise is investing capital in a Western company.

The Iridium program provides for three launches, each of seven American Iridium satellites, each with Russian Proton boosters, which amounts to 21 of the 66 to be launched under the program. At the same time plans call for the setting up of two "surface segments"—signal pickup stations.

The LKE joint enterprise has already been organized. The abbreviation LKE includes the first letters of the three participating partners: the American Lockheed Company, the State Space (K) Scientific Production

Association imeni M. Khrunichev and the NPO Energiya imeni S. Korolev. This project includes approximately nine agreements for the launch of American satellites by Russian Proton boosters into a geostationary orbit.

The entry of the Russian enterprise into the international market became possible due to support of the initiative of the Khrunichev Center by the government and the president of Russia.

Status of Russian Space Sector

State Support Versus Privatization

947Q0165A Moscow FINANSOVYYE IZVESTIYA in Russian No 36, 18-24 Aug 94 p 4

[Petr Yevseyev: "State Surrender of Space Monopoly Puts Branch Into Commercial Orbit"; the first paragraph is an introduction]

[FBIS Translated Text] The state status of enterprises in many cases is becoming an obstacle to the attraction of private investments to industry. On the other hand, state support is helping space organizations to remain afloat.

Support of the rocket-space industry always, both throughout the world and in Russia, was one of the most important fields of government activity. During the "cold war" era large-scale development work and the production of boosters and space vehicles counterbalanced the similar policy of Western countries. And at that time there was no shortage of money in the budget for that purpose.

Now that military rocket power is no longer so necessary and the money has thinned out, the rocket-space industry has found itself in an uncustomary situation and on a par with other industrial branches it has to struggle for survival. This struggle is not going successfully for all branch enterprises. The production of boosters at the Samara Progress plant has virtually stopped and the production of the light-class Kosmos booster has completely ceased.

The state, as before, is not giving up control over the branch, which retains strategic and defense importance and which represents the leading edge of Russian science and technology. But the economic situation does not allow allocation of sums in the former amounts.

Work under orders from the Defense Ministry has been reduced to the greatest degree. As a whole for rocket-space industry enterprises the percentage of armament and military technology work in the total workload was 33.2% in 1993. In 1994, according to predictions of the State Committee for Defense Industrial Branches (Goskomoboronprom), this percentage will drop still more—to 32.5%. In the best years this figure was about 70%.

However, large investments also are needed for carrying out conversion. According to data from the Goskomoboronprom, during 1993 a total of 25.1 billion rubles were allocated to conversion programs for enterprises and organizations of the rocket-space branch and the state subsidy related to conversion amounted to 31.4 billion rubles. However, possibly due to these sums the space industry, in the opinion of Valeriy Alaverdov, first deputy general director of the Russian Space Agency, was able to avoid a changeover to the production of "saucepans and frying pans," so destructive for scientific and technical potential.

The Russian Space Agency is the state client of systems and complexes for scientific and economic purposes. A total of 560 billion rubles were allocated this year for these purposes in the Federal Space Program worked out by the agency, but in addition this money comes from the budget irregularly (for the first quarter about 7% of this sum was received), according to the calculations of specialists capable of satisfying only about 30% of the economic needs of the country for space activity products.

Under conditions of absence of adequate budgeted funding and increasingly unsatisfied needs of the country for space products nothing remains other than to encourage the development of commercial activity in the branch. To be sure, state control is still retained in such cases through a system for the licensing of space activity.

The change in the situation resulted in the birth of a great many commercial space projects, usually with the participation of foreign companies or for foreign clients. In addition to the high level of Russian cosmonautics, foreigners also are being attracted by the relative cheapness of our services. The demand for use of Russian boosters for the launch of foreign satellites has increased to such an extent that the United States, for example, was forced to set restrictions on such launches for the protection of American producers.

But although commercial contracts also are becoming more attractive and advantageous than government orders for most enterprises in the rocket-space complex, the state, while proposing lower payment for work, nevertheless is guaranteeing the enterprises that they will receive a definite amount of work for some time, whereas at times a commercial client must be awaited a very long time. Commercial organizations, having more advantageous possibilities for the investment of their money, prefer not to be associated with space programs because the time for recovering costs in the best case is several years.

In many cases the state status of space complex enterprises is becoming an impediment for attracting private investments. And the changeover to a commercial basis is giving rise to a process of structural reorganization in the branch. The establishment in the main enterprises of daughter enterprises which are responsible for the implementation of definite projects, which are not state controlled and in which the potential investor can acquire his percentage of shares, is becoming a widespread method for attracting investors. This was the route also taken by the NPO imeni Lavochkin and the NPO for

Applied Mechanics, together with the state enterprise Kosmicheskaya Svyaz [Space Communication].

With respect to the principal enterprises and organizations, of the 128 making up the rocket-space industry, for 57 privatization is forbidden during 1994-1995. Thereafter, under joint stockholding conditions, in all these enterprises the state will retain the controlling percentage of shares, as was the case, for example, with the NPO Energiya.

In order to consolidate efforts and to attract financial capital for the support of space projects many space companies are quite willing to organize their own associations. This summer the NPO Molniya, although not strictly belonging to the rocket-space industry, but which constructed the Buran multiply reuseable ship for it, announced the beginning of organization of the Russian Aerospace Company and an aerospace financial group in which, according to preliminary information, up to 20 companies and about 10 Russian banks are ready to participate. Problems involved in organizing financial-industrial groups, also including in the space industry, also will be raised at an international conference on "Integration of Banking and Industrial Capital" which will be held in Moscow in November.

The Russian Space Agency also is maturing plans for structural reorganization of the branch. Valeriy Alaverdov feels that in order to optimize control of space activity it is necessary to split off from the rocket-space branch enterprises the approximately one-third which are occupied solely with the development of space technology and without which it cannot be created. These enterprises must assume the obligation of being concerned precisely with space activity and nothing else, whereas the state, in turn, will assume the obligation of ensuring them 75% of the state orders for space products, with favorable tax advantages and granting of credits. The state must work with other enterprises on a contractual basis.

But the reorganization of the branch may be complicated by the situation arising due to the government decree issued on 25 July on transfer to the Russian Space Agency of 38 enterprises earlier under the administration of the State Committee for Defense Industrial Branches. The decree in actuality deprives the RSA of its status as an independent client of work in the space field and the branch itself is under the management of two structures which will be fighting for influence in the rocket-space industry.

Communication Satellites

947Q0165B Moscow FINANSOVYYE IZVESTIYA in Russian No 36, 18-24 Aug 94 p 4

[Article by Petr Yevseyev: "State Surrender of Space Monopoly Puts Branch Into Commercial Orbit"]

[FBIS Translated Text] Space communication is the most promising field of space activity with respect to commercial profit. Despite an increasing need for information exchange both within the country and throughout the world Russia still continues to remain almost a white spot on the world communications map.

The adopted Federal Space Program for up to the year 2000 provides that space vehicles be used for increasing the number of telephone channels for fixed communication from 10 to 145 thousand and for ensuring communication for 90-95% of mobile facilities, that is, for the most part transport. The objective also is set of increasing the number of regional and commercial television channels throughout the country from 8 to 55 and increasing the number of Central Television programs from 2 to 6 with broadcasting in five time zones.

The need for space communication systems so surpasses the proposal that it even does not make it possible to speak of pure competition among different already developed and existing projects. Assuming the projects are implemented, they all will find a place in the Russian market. However, it is impossible to speak of the absence of competition among projects: since the government and private investments are unable to ensure the funding of all the initiated development work the companies must demonstrate the advantages of their projects if they are to be incorporated in the state program. The probability of finding nongovernmental funding in an amount adequate for the complete financing of a space communication project for the time being is small.

For example, the Informkosmos joint-stock company, formed by several leading companies for the construction of communication satellites (Krasnoyarsk Scientific Production Association for Applied Mechanics, state Kosmicheskaya Svyaz enterprise, Russian Space Instrument Building Scientific Research Institute, Vostok Radio Scientific Research Institute and Commercial Bank), is making Russian satellites available to foreign purchasers, using the proceeds for supporting its own programs. But according to Igor Tsirlin, general director of Informkosmos, this will not provide full funding for company projects.

Funding from the budget also does not suffice, although Informkosmos is meant to solve the important problem of replacing Gorizont satellites for the fixed communication system, in use since 1979, with more modern Ekspress satellites. The Ekspress satellites will have an increased useful life, up to 5-7 years; instead of 7 transponders (repeaters) they will each have 12 and in addition, the indices of accuracy in holding them in a constant orbit will be improved, which will lower the cost of surface receiving-transmitting equipment. Informkosmos also is working on Gals satellites for direct television broadcasting and satellites for the Arkos and Mayak mobile communication systems. But for the time being Informkosmos is forced to supply satellites in principle intended for Russia to foreign clients capable of paying for them. The first Ekspress satellite will be launched in October under contract with Intersputnik;

the launch of the second is planned for late this year—early next year under contract with the Rimsat Company, whose headquarters is located in the United States. Plans also call for the first Gals satellite, launched in January, together with Intersputnik, to be made available for the use of foreign clients. "To be sure, it is a pity," states Igor Tsirlin, "that this development work is not being done primarily for Russia, but we are forced to earn money in order to invest it in the further development of promising communication systems." Not less than 300 million dollars is needed for implementation of the Informkosmos programs in these three directions.

Feeling the enormous and unsatisfied demand for space communication systems, many companies previously not engaged in such activity have begun to be active in this field. The NPO imeni Lavochkin, having great experience and technologies from the development of space research vehicles, such as the Luna, Venera and lunar rovers, and from work under defense orders, in 1991 began work on the Zerkalo system and other space communication projects. The Zerkalo project is included in the state program and has received broad international recognition. It calls for the launch of only a single satellite which will not cover the entire territory of the country, but only ten economically active regions. While losing in the globality of communication, the Zerkalo, due to the concentration of rays, will ensure more powerful signal transmission, which will considerably reduce expenditures on constructing the surface infrastructure. As a result, the Zerkalo will be able to offer its clients service rates which are even lower than for the INTELSAT, one of the most inexpensive in the world.

During 1991-92 Russian commercial organizations began funding of system development. In the search for funding and potential Zerkalo users the NPO imeni Lavochkin organized the NST Company, which subsequently with the involvement of foreign private companies received an international status. According to its vice president, Nikolay Morozov, the Zerkalo will be capable of docking with any other satellite communication system and if sufficient resources are available may already be launched after 1 ½ years.

Among the several communication projects of the NPO imeni Lavochkin that which has received the best renown is the Bankir system, which should provide the banking system of the country with space communications and which is supported by the Central Bank of Russia.

Choices Among Competing Projects

947Q0165C Moscow FINANSOVYYE IZVESTIYA in Russian No 36, 18-24 Aug 94 p 4

[Article by Petr Yevseyev: "Sorry State of Budget Dictates Choice Among Space Priorities"]

[FBIS Translated Text] Under conditions of an acute shortage of funds in the Russian budget, the state, which intends to retain control over space activity for itself, must as never before seriously make a choice among the great many space programs of those which must be given priority. The problem at hand is far tougher than a choice between the programs needed by the country and those which are unnecessary. The country is now by far in no position to support all the necessary programs and it must select which programs are more worthy of support and which are less so.

In any case this choice is incorrect with respect to space industry enterprises because the state is denying existence to projects which are only a little or not at all inferior to those which have been promised support. But nevertheless there is no escaping reality and in distributing the allocated budgeted sums among all the promising programs the state is ruining them all because in this case no one will have the full amount needed.

The state, in the form of the official state client for work in the civilian space field, the Russian Space Agency, had to proceed on the basis of these new economic conditions in order in December 1993 to adopt a Federal Space Program up to the year 2000, which defines the objectives of national space activity. According to Valeriy Alaverdov, first deputy general director of the RSA, "the high exactingness in the determination of priorities, in order not to lose what is most important and to avoid what is secondary, which will be done later, resulted in the appearance of two new approaches in preparation of the program." First of all, the decisive word in implementing projects will belong to the clients and the future users of the systems, whereas earlier the technology was first developed and then already in finalized form was offered to the user, resulting in predetermined possibilities. Second, the need for independent expert evaluation appeared. A special agency was established for evaluating the programs—an Interdepartmental Expert Commission headed by Yuriy Osipov, president of the Academy of Sciences.

Today it is an achievement that in working out the Federal Space Program it was possible to include in it all the principal directions in cosmonautics existing prior to the restructuring. Nevertheless, according to Valeriy Alaverdov, in the program they are all represented in compressed form. With respect to individual aspects of the program, the most important problems for the country are those related to communication and telecommunications, which in this review are examined in a separate article. The aspects of Russian launch equipment also are described separately. Otherwise the problems of Russian cosmonautics look as follows.

In the field of navigation up to the year 2000 it is proposed that all aircraft and ships be outfitted with appropriate space systems without which all large airports and ports would probably soon cease to accept them. It also is proposed that the accuracy in determining their own position be increased by a factor of 10.

In the meteorological field plans call for increasing the advance time of weather forecasts from 3 to 10 days.

Work on remote sensing of the Earth will be continued using the Resurs and Okean systems.

In fundamental science work is to be continued in those fields where Russia has a well-developed school and a strong instrument base. This includes research on solar-terrestrial relationships, astrophysics and astronomy. Programs for studying the planets have been most strongly cut back.

In speaking of plans for using cosmodromes, Valeriy Alaverdov notes that the ratification of the agreement on the leasing of Baykonur, for which Russia will pay Kazakhstan 115 million dollars a year, also will enable it to carry out its launches there in the future. Plesetsk is then to become the principal purely Russian cosmodrome. But its transformation to the main launch base of the country is impeded by three problems: the northern latitudes, requiring more powerful launch facilities and reconstruction of the cosmodrome, higher requirements on the ecological purity of launches dictated by the great population density in the region, and an extension of the zones of falling of the separating stages of boosters, which necessitates changes in the control system. The construction of a cosmodrome in Primorye involves the need for great monetary investments for the cosmodrome itself, a long time for constructing the launch facilities, remoteness from the places of construction of rocket-space equipment and a low level of development of the local infrastructure. Nevertheless, according to Valeriy Alaverdov, work in this direction is continuing.

The RSA also has included in the list of priority directions a manned cosmonautics program, a field in which Russia still retains world leadership. The decision to build an orbital station jointly with the Americans also is regarded as correct, especially since by 1997 the Russian Mir station, now flying in orbit, should cease to exist, having already exceeded by four times its projected useful life.

Expendable SLVs for Next 10-15 Years

947Q0165D Moscow FINANSOVYYE IZVESTIYA in Russian No 36, 18-24 Aug 94 p 4

[Article by Petr Yevseyev: "Russian 'Shuttles' for the Time Being No Competition for Rockets"]

[FBIS Translated Text] One of the most commercially successful directions in space activity for Russia is becoming the use of our country's boosters for the launch of satellites into orbit on the orders of foreign clients. After simplification of the procedures for international cooperation Russian boosters, especially the Proton, are successfully entering the international market for commercial launches.

A specially organized joint enterprise made up of the American Lockheed aerospace group, the Khrunichev Space Center, the builder of the Proton booster, and the NPO Energiya is engaged in the sale and marketing of the Proton on the world market. The joint enterprise has announced that after the first commercial launch of the INMARSAT satellite it received orders for 600 million dollars.

Such a success of the Proton has been due both to its reliable reputation and its low cost. Whereas the price for launch of a French Ariane booster, which is the leader in the market, varies from 60 to 80 million dollars, the international price for launch with the Proton is about 40 million dollars. For the internal needs of Russia a Proton launch costs about 14-15 billion rubles.

For the time being nothing threatens the position of booster producers in the internal market. In Russia, according to Valeriy Alaverdov, first deputy general director of the Russian Space Agency, in the next 10-15 years plans call for launches with SLVs. In the opinion of the RSA, today they are the cheapest aerospace systems, have already been tested by time and as before solve all the necessary problems. Work only on the modernization of old and construction of new boosters is being supported. For example, on a competitive basis a study is being made of the construction of a heavy-class booster which is more powerful than the Proton and which has improved ecological characteristics. There is a plan for the construction of the new Rus booster, which with a launch from the Plesetsk cosmodrome may be competition for the Soyuz booster, now used for launching manned modules from Baykonur. Modernization of the Energiya booster, once launching the Buran ship into space, also is being examined.

The Buran itself will probably never fly again. It is the opinion of specialists that it was far ahead of its time. Its capability to put up to 30 tons of payload into orbit remained unused and for the launch of lesser payloads it becomes inefficient. Beginning in the 1990's the allocation of sums for supporting the operability of the Buran began to decline and this year its builder, the NPO Molniya, no longer received anything for it.

Despite the apparent absence of any prospects for the immediate future, Russian enterprises are continuing the development of aerospace launch systems which in the future may be able to replace SLVs. This same NPO Molniya since 1983 has been working on the MAKS project, a multiply reuseable aerospace system. Its basis is a small returnable orbital ship approximately four times smaller than the Buran and a fuel tank used but a single time. All this will be made airborne using the Mriya heavy aircraft. It is the opinion of Aleksandr Bashilov, general director of the NPO Molniya, that after its construction such a system will make launches five times cheaper than with a rocket. But the implementation of the project will require about 2 billion dollars, of which about 1 billion has already been invested.

Now the MAKS project and other aerospace projects existing, for example, at the Raduga Design Bureau, for all intents and purposes have been put off by the government to better times. The RSA points out the difficulties with funding and the necessity for an analysis of

needs for constructing new aerospace systems so that after their construction they will not remain unused, like the Buran. Aleksandr Bashilov feels that the cool attitude of civilian space toward such multiply reuseable systems also is based on the opposition of the builders of SLVs, fearing being squeezed out of the space launch market.

Aerospace Congress Participants Discuss Funding Shortages, Long-Term Plans

947Q0161A Moscow SEGODNYA in Russian 25 Aug 94 p 9

[Article by Veronika Romanenkova: "Space Scientists Await Favors From Government. Scientific Fantasy and Real Money"]

[FBIS Translated Text] The reanimation of the Russian aerospace complex is impossible: such a conclusion was drawn in a report of the leading businessman and politician Konstantin Borovoy which was presented at the International Aerospace Congress which was held last week in Moscow. The principal premise for such a conclusion was the catastrophic insufficiency of funding for the branch and the impossibility of obtaining money in an adequate amount in the foreseeable future.

However, by no means all the congress participants agree with this assertion, declared Professor Mark Liberzon, chairman of the organizing committee, to a SEGODNYA correspondent. For example, a representative of the European Space Agency (ESA) does not at all regard the restrictions on national budget appropriations to be anything unusual. As he sees it, this is a misfortune shared in common. The ESA also is constantly dependent on private companies and is fighting for foreign clients. The NASA budget is periodically chopped by the American congress. Accordingly, on the basis of the results of the forum an appeal was made to all the governments of the countries engaged in space activity in which specialists insist on an increase in state appropriations for space.

It was entirely logical to assume that under conditions of rough competition in the world space market still another competitor in the form of Russia is undesirable. This fact is constantly emphasized by Yuriy Koptev, general director of the Russian Space Agency. However, as experience shows and as the congress once again demonstrated, there are very many who are striving to make contacts with us. Among the examples it also is possible to mention the constant flights of foreign astronauts in the Mir and the construction of an international orbital station and the lines forming for launches of our boosters, especially of the heavy Proton.

Other countries are entering into cooperation with us because in the present stage of technological development it is a rare project which is within the capabilities of an individual country. It is still more attractive that by "loading down" Russia foreigners can exploit the poverty of its specialists and scarcely are going to give true value for their work.

Nevertheless, the Russians themselves are constantly straining to be in action. For example, at the congress Vladimir Senkevich, a representative of the Central Scientific Research Institute for Machine Building, the leading national institute for rocket-space technology, presented to the stunned audience "A Long-Range Space Program for Mankind for the 21st Century." The project, at first glance, seems to be science fiction and its implementation is possible only with adequate funding and global cooperation.

However, the "space program for mankind" and the postulated returns from it in actuality are impressive. Among its principal directions the specialist mentioned, in particular, the removal of radioactive wastes from our planet to the sun or beyond the limits of the solar system. The wastes can be transported by means of the Zenit booster or a multiply reuseable booster of the Energiya type. He feels that by the years 2015-2025 the removal of 800 tons of wastes per year is entirely realistic and by 2025-2040—1200 tons per year.

Plans for using space vehicles for contending with asteroids, constituting a threat to the Earth, look no less attractive. Or a global military safety system. Not as unwieldy as the SDI, it could be created under the aegis of the UN in 25 years, declared Vladimir Senkevich.

More "down-to-earth" plans also were formulated at the congress. Piter Kramer, director of the German Space Agency, gave hopes to the NPO Energiya and the Central Scientific Research Institute for Machine Building for less significant but more immediate contracts. He promised to return to Moscow literally within a month for their signing. Close cooperation on the development of returnable space capsules was agreed upon between the Moscow State Aviation Technology University and the University of Pennsylvania in Philadelphia.

Arguments of U.S., Russian Opponents of Alpha Station Project

947Q0162A Moscow SEGODNYA in Russian 25 Aug 94 p 9

[Article by Mikhail Chernyshov: "Star Wars Against 'Alpha.' Orbital Station as a Bone of Contention"]

[FBIS Translated Text] The idea of constructing a space research complex which is common for all, simple at first glance and seemingly attractive for the participants in the cooperative effort—Russia, United States, Canada, Western Europe and Japan—is again being subjected to attacks from government and private organizations. For the time being the Alpha supporters are holding their own under the blows, but how long this will continue is unknown. The contending sides apparently are not ready for compromises. Analysts are being asked the question: "is the Alpha a bridge connecting the technologically well-developed countries or a 'give-away' for the international military-industrial complex, assisting government budgeters to keep it all afloat?"

The first salvo against the project already thundered in late July. The US National Research Council, in a letter to Daniel Goldin, NASA administrator, emphasized that virtually nothing remained in the Alpha which had been planned for the American Spacelab orbital structure. The authors of this letter also asserted that American scientists should not lay great hopes on joint work with the Russians in the fields of space biology and microgravitation, which it is proposed be carried out in the Mir orbital complex. The outdated station equipment will not make it possible to obtain interesting results. And transport of the latest Western instrumentation to the station means to be drawn into additional expenditures. Work on the Mir is regarded as the initial stage in implementation of the Alpha project.

In early August the United States Senate, as was reported, "under Star War conditions," discussed the draft of the NASA budget for the next fiscal year. Alpha once again became the sharpest point of debate. A report of the General Accounting Office was disseminated among the senators in which it was asserted that cooperation with Russia not only would not bring the United States any financial advantages, but also, on the contrary, would require the appropriation of an additional 400 million dollars.

This time Goldin was forced to come out with a special statement in which he explained that the report distorted the essential facts: no one has said that additional funding would be required, the only costs involved are already included in the NASA budget. The agency administrator again repeated the principal arguments in support of an international station: a shortening of the time needed for implementing the program, a decrease in expenditures for all cooperating participants and a reciprocal exchange of high technologies. But not all these arguments seem to be convincing.

Objections to the project also are continuing from the Russian side. In particular, some military analysts believe that by participating in the Alpha project Russia is losing more than it is gaining. In the pursuit of a mythical foreign exchange inflow we in essence are giving up our own manned flight program. Work on the next-generation orbital station Mir-2 and multiply reuseable ships has been curtailed. In Alpha, even if the project is successfully carried out, Russia is far from being allocated a leading role.

Many civilian specialists agree with this. Western estimates of the financial contribution of Russia to Alpha are incorrect. For example, Professor Grigoriy Khozin, a well-known specialist on the political- juridical aspects of cosmonautics, is convinced of this. He objects to the American SMI experts who assert that if the United States intended to spend on the station approximately 2 billion dollars a year, Western Europe and Japan—about half this sum, the fraction of Russia remains unknown. If one wishes the contribution of Russia can be easily calculated. The Russians are constructing the base unit for the station, solar power plant, docking units and life support system and are providing the means of transport (boosters) for ensuring complex operation. All the expenditures taken together add up to approximately one-third of the total cost of the Alpha.

Cooperation can be effective only with an equality of the partners. It is written in the American program documents that the core of the Alpha should be their own development work, and all the rest is supplied by the partners to one degree or another, but again applicable to the needs of the United States. It is completely ignored that the cooperating participants may have their own interests.

The Americans are basing relations with Canada, Western Europe, Japan and Russia on different principles. Whereas the juridical aspects of cooperative effort with the Western partners are stipulated literally down to the last letter, agreements with Russia are of an approximate character. And what is interesting, the uncertainties are clearly deliberate because they can be interpreted only to the advantage of America. NASA, as the chief client, under American laws in actuality is becoming the complete master of the station. Russia retains the right to use some research results, but only with permission of the American agency. "Glancing through" these points in the agreement, Russia appears to be driven into a corner. The reason is juridical illiteracy. We are solving technical cooperation problems relatively competently, but from the juridical point of view we are turning out to be a second-class partner.

Cosmonautics is assuming a new character. Today it can be developed only within the framework of international cooperation. At an individually taken national level, that is, under isolation conditions, in the absence of competition and with constant pressure from the outside, a weakening of cosmonautics, its scientific and technical level, inevitably begins. With respect to Russia, it has moved on from "reliance on its own efforts" and rigorous centralization to another extremity: each department and even individual enterprises are developing their own "development concepts," seeing a way out from the blind alley in an orientation exclusively on the foreign market. Under these conditions Russia has an extreme need for a general analysis center capable of bringing together the technical experience of industrialists and the juridical knowledge of humanitarians.

Meanwhile debates about the Alpha are continuing in the American congress. And if it is taken into account that many decisions are sometimes made in both the upper and lower houses by a majority of only a few votes, it is difficult to predict just how the balance may swing.

Alpha Station Assembly Schedule, Issue of Flight Control Discussed

947Q0162B Moscow SEGODNYA in Russian
25 Aug 94 p 9

[Article by Viktor Gritsenko: "NASA Seeks Way To Retreat. The United States or Russia—Who Is More Important?"]

[FBIS Translated Text] There is now already a seventh revised plan for an international space station (ISS). Its developers are apparently operating under the proverb: "measure seven times, then cut once." Work on drawing up the seven ISS plans has already cost 11.2 billion dollars.

In the immediate future the detailed refinement of the project will be continued and its last "critical" discussion should take place in April 1995.

NASA in the United States has prepared a "standby" variant of work under the ISS program in the event of a "divorce" from Russia. This is evidently attributable to the well-known failure of the Russian side to meet its obligations—as an example it is possible to cite the nonperformance of its obligations by the Russian Space Agency, as a result of which the implementation of the Mars-94 international space project was postponed to 1966. It is true that with this switching to the "side track" the time for putting the international station into operation will be delayed by one year, which will increase American expenditures by 2 billion dollars.

The beginning of ISS assembly is set with the launch in the summer of 1997 of a Russian Proton booster which will put into orbit a functional- cargo unit developed in our country—the basis for the future station. The first American launch under the ISS program also should take place in December of that same year: the orbital stage (OS) Endeavor is to be directed into space.

The beginning of work on ISS assembly will be preceded in 1995-1997 by 11 flights of American shuttles to the Mir orbital station and 10 dockings with it. The Atlantis and Discovery OS will be equipped for this purpose with units for docking with the Mir. The Discovery flight for rendezvous with the station is planned for 2 February 1995, but the first docking of the Atlantis with the Mir should take place on 30 May. A total of 6 dockings of the Atlantis and 4 dockings of the Discovery are planned.

In order to assemble the ISS over the course of five years there will have to be 16 flights of the shuttles and 13 launches of Russian boosters. In addition, there will have to be not less than five flights a year for fuel delivery and raising the station orbit. This is a minimum of 54 launches up to mid-2002 when the station with a permanent crew of 6 persons aboard should be put into operation.

Russia will deliver its crews in modified Soyuz TM ships of the so- called hundred series. Rescue ships will be used in order to ensure safety of crew members in case of a need to abandon the station on an emergency basis. Cargo will be delivered to the station by modified Progress M cargo transport ships and then by a new Progress variant with a grea:er lift capacity, put into orbit by a Zenit booster.

In addition, Russian and American specialists must still develop a standardized space suit to be worn when conducting activity outside the ship, but there is still time for its development.

In the United States a very careful study is being made of how the use of Russian structural components may exert an influence on station safety. The United States also has already firmly decided that monitoring and control of the station will be done exclusively by Americans.

Our specialists are not giving in and want to control the station from Russia. For example, Vladimir Solovyev, flight director for the Mir station, feels that "we still will control the entire ISS for a quite long time, and its Russian segment for sure. No matter what our bosses signed over there, life will go on," declares Mr. Solovyev.

Risks Seen for Russia in Alpha Station Program

947Q0163A Moscow KRASNAYA ZVEZDA in Russian 27 Aug 94 p 5

[Article by Valeriy Baberdin: "Alpha—Common Dwelling Place for People of Our Planet"; the first paragraph is an introduction]

[FBIS Translated Text] Quite a bit has been written and spoken about the construction of the Alpha international space station, or as it was initially called, the Freedom - Mir-2. And nevertheless this subject is still far from exhausted. At a recent forum of cosmonauts and astronauts of our planet—the Tenth International Congress of the Association of Spaceflight Participants—there again was discussion of this project. And this is understandable. After all, in essence what is involved is talk of creation of an exoplanetary, world cosmonaut detachment whose common space home will be the Alpha. It is possible to build this orbital station only by bringing together the efforts of the space industry of Russia, United States, Central Europe, Japan and Canada.

According to calculations of American experts, the complete assembly of the orbital station will require a minimum of 54 space vehicle launches. Under the plan they will begin in November 1997. For the most part in the construction work plans call for the use of our Proton boosters, the Soyuz-Progress transport systems, as well as the American Shuttles. Later, during Alpha operation, the French Arianes and the Japanese H-2s also will deliver cargo. In May 1998 the first permanent orbital expedition is to be sent to the Alpha. However, it is proposed that the last touch in the station construction plan be introduced during the June flight in the year 2002.

Astronaut John Blaha, a NASA representative, in his report at the congress, mentioned the unusual volume of cargo flow. It will require serious changes in the existing infrastructure, to be more exact, the creation of a new, superpowerful infrastructure. But most importantly there must be a complete reexamination of the philosophy of spaceflight organization. The fact is that the Russian and American philosophies have healthy differences from one another. As emphasized by Blaha, in the United States an astronaut is regarded as part of a machine. He acts independently, relying on information from shipboard instruments and information received

from the surface flight control center. In Russia, on the other hand, cosmonauts are standbys for automatic systems. They act in their role in the event that any component malfunctions. The systems are accordingly multilevel and have several degrees of protection.

The two concepts must be reexamined and made compatible. This also is a problem. And also such a question, for example, as to what space suits will be worn in open space? Our cosmonauts have grown accustomed to theirs and consider them to be more convenient. A standardized space suit must be developed. Still another fine point is medications. They also are different, as are the methods for their administration. And such nuances are highly important.

The first step in assembly of the Alpha, this space structure of the century, is to be the task of Russian cosmonautics. A so-called functional-cargo unit (FCU) will be put into orbit by a Proton booster.

Our Summary

The FCU is the power unit. In the design documentation of the Khrunichev State Center it is listed under the name "item 77KM." In its time it was designed as a supply transport ship for manned flights to the Almaz station. It was put into orbit four times and proved itself to be a good cargo ship, tanker and tug. Later the FCU became the base for constructing modules for the present-day Mir-Kvant station, Kvant-2 and Kristall vehicles, and those which are being prepared for entry into orbit—Spektr and Priroda.

Why is it called the energy unit? The fact is that it is proposed that its tanks carry the fuel supply for the entire Alpha, but solar cells and storage batteries will initially supply current for the Russian and American modules. According to current plans, all the design documentation must be finalized prior to 30 September. It is necessary that the FCU be constructed by 30 September of next year and that tests be completed by 30 November 1996.

The functional-cargo unit will become the core for the further development of the station, a singular space port. It will have six docking units: one in the tail part and five on the spherical section. The next flight also is ours. The first docking unit, similar to that which we have on the Mir station, will be put into orbit by means of a Soyuz booster. Then we will launch a Proton and connect a so-called service module to the orbital system. The result will be a fragment of a station which is capable of receiving an expedition. From that moment it will become manned. It will constantly be manned by two or three cosmonauts (astronauts). The duration of the stay of Russian specialists, taking their experience into account, is planned to be increased to 180 days; for the Americans it will be no more than 90 days.

Shuttle flights will come next. Laboratory modules will be put into orbit, but most importantly, an enormous three-dimensional beam with four powerful solar cells, with its own heat-regulating system, with a platform for instruments for scientific experiments and with an outlying engines for Alpha orientation will be constructed. Its assembly will require many flights not only of the Shuttles, but also our boosters, and also a good many walks in open space. Then the station will be further developed: European and Japanese modules, Russian and American modules... The Alpha crew, after the structure is completed, will be six persons.

I listen to Blaha, look at the slides—graphs, sketches and diagrams. Everything has been taken into account down to the smallest detail. For example, there is a cyclogram of the Shuttle flight for the installation of solar cells on the three-dimensional beam. Ten days in orbit: launch, checking of operation, activation of the TV circuit, approach, hovering, docking, work with the manipulator, walks in open space... And nevertheless doubts abound. Is not everyone being carried away with gigantism? Does not this project await the fate experienced by the Freedom? After all, American specialists worked for many years and did not succeed in embodying in metal that which had been drafted on paper because funding did not suffice. Even now 11.2 billion dollars have already been spent just on the development of different variants of the orbital station. According to recent data, the estimate of expenditures before the Alpha is put into operation will be 17.4 billion dollars and this sum does not include the cost of Shuttle launches nor those sums which will be invested by other partners, including Russia.

And there are still other questions. Will our Russian industry be involved in this project? After all, for the time being we have enormous funding problems. There are also more than a few problems with our neighbors in nearby countries. Where is the guarantee that at some stage, not having received credits, we will be forced to withdraw from the action, not fulfilling our agreements? NASA is now attempting to solve its financial problems with the assistance of Russia, counting on our docking units, modules and inexpensive space vehicle launches.

Yes, we have enormous experience with long-term stays in space, organization of operation of long-lived orbital stations, but we also are handing this over to the Americans. And what if suddenly the time comes when we are no longer of interest to our partners? We are giving away all the know-how. Indeed, we are in essence giving up our national manned space program. We are working only on the Alpha.

There are many questions. And our cosmonauts, despite all the interest in the project, have a far from unanimous opinion concerning it. In addition, listening to the addresses of American specialists, you involuntarily sense that they regard the station to be exclusively theirs. We will simply assist them in building it.

This was even seen in the discussion of such a key problem as flight control. Until now it still has not been decided from what flight control center this control will

be exercised: Kaliningrad in the Moscow region or Houston. At one time a protocol on disagreements was even prepared, signed by representatives of NASA, the Russian Space Agency (RSA) and the NPO Energiya.

The following control model was proposed. Its principal body was to be a Space Station Control Council. It was to include representatives of all the countries participating in the project, but was to be headed by a NASA specialist. Naturally, it was to be located in Houston. It was planned that communication with space vehicles would be via a Joint Station Flight Control Center, consisting of the flight control centers at Houston and Kaliningrad.

However, not so much time remains before completion of the discussions. The next round of discussions of the project in the American congress is planned for December. In April it is proposed that the Alpha be reduced to its final variant.

What are the chances for success in the congress? In the opinion of American astronauts, they are greater. Whereas during its first examination last year the project was approved by a majority of one vote, now this majority has already grown to 100 votes.

However that may be, the train has gone on. Sergey Krikalev was the first of the Russian cosmonauts to make a flight in the Shuttle. Now Vladimir Titov is preparing for the same flight. In early February of next year the ship should approach the Mir, hover and "run through" the docking process. However, the first real docking of the Shuttle with our station is planned for May 1966. The operation is unique. The masses of the space systems are enormous. How will the station behave? It is not by chance that Viktor Afanasyev, just returning from space, at the congress declared that it is necessary to check the strength of all the welded seams of the Mir orbital complex transfer compartment.

SEGODNYA has learned the first Russian-American crew of the Soyuz which will be launched in the spring of 1995. It will be made up of the commander Vladimir Dezhurov, ship's engineer Gennadiy Strekalov and as the astronaut-researcher Norman Thagard, an astronaut, a highly qualified specialist in the space medicine field. In addition, 10 other Shuttle flights to the Mir and dockings are planned with a total presence of American astronauts aboard for 24 months. A plan for flights of our cosmonauts in American ships also has been drawn up for several years. The fact is that general planetary problems also must be solved by all-planetary efforts.

Khrunichev State Center Chosen To Develop 'Angara' Heavy Booster

947Q0167A Moscow KOMMERSANT DAILY in Russian 2 Sep 94 p 9

[Article by Aleksandr Malyutin: "A Hundred Tons Can Be Directed Into Space"; the first paragraph is an introduction]

[FBIS Translated Text] According to a communication of the press service of the Khrunichev State Space Scientific Production Center (GKNPTs), which was disseminated yesterday, the Russian Space Agency and the rocket-space forces of the Russian Ministry of Defense have made a decision to construct the new Angara rocket complex, capable of putting an unprecedently heavy payload into orbit—up to 100 tons. Several alternative proposals were examined on a competitive basis and the most acceptable was deemed to be the variant proposed by the GKNPTs. The victory of its proposal over those of the NPO Energiya and the design bureau at Miass (Chelyabinsk Oblast) was favored by the "commercial efficiency of the Angara project."

The state organizations which required a new superheavy booster were guided, it must be surmised, by their own internal considerations. Probably (although the procedure has still not been determined) they also will fund the development of the Angara completely or in part. The concept of "commercial efficiency" of a state organization is interpreted, in actuality, in one's own way, but judging from the fact that all the rockets which are now being produced by the GKNPTs can be used and are being used for commercial launches, the Angara also will serve big business. As is known (we have told about this), the Lockheed- Khrunichev consortium is succeeding in finding a commercial use for Proton boosters and the GKNPTs and Deutsche Aerospace are close to the signing of new agreements (in this case reference is to the use of Rokot rockets).

The booster, which can put a payload of 100 tons into orbit, could, according to GKNPTs representatives, greatly lessen the cost of the Iridium satellite communication project. But the development of the Angara will be completed only in 1998-1999 and the first launch will be in the years 2000-2002. So that the Teledesic project of the American billionaires Bill Gates and Craig McCaw (we have told about this)—the organization of a global satellite communication system by the end of the century—competing with the Iridium project, will scarcely be able to use the Angara. In that project it is planned that 840 satellites will be launched and some experts feel that it will not be possible to utilize such a great number in the next five years. But by that time there will certainly be a demand for the Angara from someone else.

Among the merits of the Angara booster which influenced the decision of the competent commission it is necessary to mention the possibility of repeated use of the first rocket stage. Until now the first stage of Khrunichev rockets tumbled downward in the 115th second of flight, where it hit and contaminated the terrain. In addition, the Angara, according to the plans of those drawing up the project, can be launched from the Russian cosmodrome Plesetsk, which will make it possible to save on lease costs at the Baykonur cosmodrome.

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